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THE CHALLENGE.

W. S. RODMAN,

Vice-President of the Society.

The Society is now well started on its second third of a century, and may look back with a very considerable degree of pride and satisfaction to an honorable record of achievement. Nevertheless, there have been all too many occasions for just criticism concerning the dearth of real accomplishments of merit. Able individuals and enthusiastic groups have, from time to time, called attention to vital matters, which have been discussed at length, often in desultory fashion, rarely with notable spirit. Both presentation and discussion have then been embalmed in the transactions without ever having been given an adequate chance to survive and serve.

To a considerable degree, the situation mentioned has been due to the lack of an authoritative body which might serve to nourish and foster those worthy suggestions and virtually to force more universal attention to their importance to the end that they should not die but might live and grow.

Probably the most constructive piece of legislation ever produced by the Society was the action which brought into being the Board of Investigation and Coördination. May it never be abolished! For months now, under its supervision, there has been witnessed an unprecedented activity and coöperation by individuals and committees in educational institutions, in national societies and in industries, from which has flowed a seemingly endless stream of data touching the most obvious and the equally important but commonly overlooked factors arising in and affecting matters of engineering education. Reports chronicling these activities have filled completely the programs of the last two annual meetings.

The mass of material presented for study has been staggering and, to some degree at least, has had a tendency to produce mental indigestion unless taken in homeopathic quantities.

The work so far accomplished is, however, but a bare introduction and herein lies the challenge. Some, it may be feared, will now wish to sit back content with the idea of having done well the specific work assigned. A great danger lurks here and it must be carefully circumvented. The immediate future should be devoted to a universal, calm, dispassionate study of the facts already presented or soon to appear. With the facts well digested, then must follow the even more strenuous and important task of gradually bringing about those desirable changes in the manifold matters of vital import by the concerted and coöperative efforts of all agencies interested in promoting engineering education. The well-oiled machinery which has functioned so admirably during the preliminary fact-finding period must not be allowed to lose the momentum which has been accumulated. Indeed, added impetus is necessary for sanely and gradually bringing to fruition the abundant buds which are revealed by even a casual reading of the excellent summaries presented by the Director and Associate Director of the investigations.

No similar opportunity for rendering such great service has ever been presented to the Society under such happy auspices and favorable auguries for a successful outcome. The best efforts and ablest contributions of the Society members must be made freely and earnestly available, probably to the extent of abandoning pet theories and individual ideals to work for the common welfare.

Many members of the Society are likewise members of national professional societies and these should work especially to help maintain the needed coöperation of those agencies in the solution of mutually vital problems. The Society membership should approximate one hundred per cent enrollment of those individuals who are concerned in the teaching of future engineers. Let each present member consider himself or herself to be a committee of one, with a duty of bringing into the

Society membership as many colleagues as possible so that mutual understanding of the problems to be solved may be as complete as a strong organization can make it.

With these ideas in mind every member may well feel that the real job is just beginning, and that the results which may be accomplished will fully repay all effort expended in obtaining them. The task will be hard and long; in truth, it will never reach an end. It must never be completed, since that would indicate a failure to progress and, as in all other human activities, failure to progress could mean but the beginning of decay.

Will the Society fail to meet the challenge? Time alone will tell, but hope rises strong and "where there's a will, there's a way."

ENGINEERING GRADUATES AND NON-GRADUATE FORMER STUDENTS *

Purposes.—The purposes of this study were to obtain as accurate and complete information as possible regarding the careers of engineering graduates and the relationship of their work to courses pursued in college; to determine the means through which they obtain first positions; to gather information regarding their early experiences and adjustments to industrial life; and to obtain their opinions regarding various phases of engineering education. It was also the purpose to prepare recommendations on various matters relating to engineering graduates, particularly in relation to the placement process and to the continuation of study after leaving college.

Sources of Information.—Data relating to engineering graduates and former students were obtained by means of questionnaire studies carried out through the cooperation of committees of the faculties of a representative group of engineering colleges in the United States and Canada. The following numbers of institutions and of graduates are represented in the tabulations:

1. Recent Graduates—Classes of 1922, 1923, and 1924—43 institutions and 3,933 graduates, representing 47.9 per cent of those canvassed.
2. Older Graduates—Classes of 1919, 1914, 1909, 1904, 1899, 1894, 1889, and 1884—34 institutions and 2,336 individuals, representing 35.2 per cent of those canvassed.
3. Former Students, Non-Graduates, of the classes of 1924, 1919, 1914, 1909 and 1904—14 institutions and 721 individuals, representing 21.5 per cent of those canvassed.

Approximately one-sixth of all engineering graduates of the classes of 1922, 1923 and 1924 are included in the tables. This is probably a fair sampling of the more recent graduates. The number of older graduates is a much smaller percentage

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of the whole body of graduates of classes prior to 1922. It is felt, however, that the method of sampling by canvassing classes of each fifth year and of institutions representing the various types and geographical locations of engineering colleges gives a fair cross-section of the older graduates. It is believed, therefore, that the information is sufficiently representative to warrant definite conclusions. It is doubtful, however, if the returns from non-graduates are sufficiently complete to warrant other than the most general inferences.

Auspices.—The study was carried out under the sponsorship of the Committee on Engineering Students and Graduates:

R. L. Sackett, *Chairman,* Pennsylvania State College,
E. B. Roberts, *Secretary,* Westinghouse Electric and Manufacturing Company,
Edward Bennett, University of Wisconsin,
J. W. Hallock, University of Pittsburgh,
G. B. Pegram, Columbia University,
R. I. Rees, American Telephone and Telegraph Company,
H. P. Talbot, Massachusetts Institute of Technology.

The committee has presented two reports; one in June, 1925, and one in June, 1926. These two reports with such editorial changes as were needed for the purpose, together with accompanying tables of data, have been consolidated and constitute the material which follows. It has been divided into two parts corresponding to the two reports mentioned. The first presents the information and statements of opinion gathered from graduates. The second sets forth the conclusions and recommendations of the committee.

PART I. DATA AND OPINIONS OBTAINED FROM ENGINEERING GRADUATES AND NON-GRADUATES

(The tables of data referred to will be found on pages 201–216 inc.)

A. Occupations and Earnings of Graduates

General Fields of Activity.—In Tables 1 to 5 inclusive are exhibited statistics relating to the important and much dis-

cussed question of the actual occupations of engineering graduates and the relation of lines of occupation to courses of study.

Table 1 presents the general classification of fields of work of graduates who have passed through the somewhat unsettled first five-year period; 25 per cent state that they are in work of a definitely professional character, 41 per cent in the general industrial field, 16 per cent are in commercial positions, 4.5 per cent are doing financial work, and the remaining 13 per cent are either in governmental employ or are in miscellaneous types of positions. A comparison of the fields of work of graduates of earlier and later classes indicates that a greater proportion of the former class themselves in the professional group, and a smaller proportion in the industrial and financial groups. On general consideration it seems unlikely that any considerable proportion of the graduates of a given class turn with increasing experience from industrial and financial positions to those of a more strictly professional character. Hence it seems probable that this larger showing of the older classes in the professional groups means that in former years the engineering graduate was more intent upon private professional work, and that of late years graduates are going to an increasing extent into the employ of industrial concerns. It is possible, of course, that the replies—particularly those from the older classes—are not strictly representative, but other information not shown in the tables tends to confirm the conclusion that the independent private practice of engineering is distinctly on the decrease and that engineers to a greater and greater extent are going into the employ of corporate organizations, particularly of the large industries.

Occupations as Related to Course Pursued in College.—Tables 2 and 3 and Fig. 1 show the relationship of fields of work of graduates to courses pursued in college. Fig. 1 is a composite of the data of Tables 2 and 3. In both tables and figure the "same field" includes those sub-divisions which are usually recognized as a part of the major field itself. Sanitary and hydraulic engineering, for example, are taken as

parts of civil engineering. "Closely associated fields" are those closely related to the major fields, such, for example, as marine engineering as related to mechanical engineering. "Unassociated engineering field" may be illustrated by the case of a graduate of civil engineering who is employed in electrical engineering work. It will be noted that 60 per cent of all graduates who supplied information are in the same lines of work as their college courses, approximately one-quarter are in "closely associated" or "unassociated" lines of engineering, and the remaining 15 per cent have left engineering.

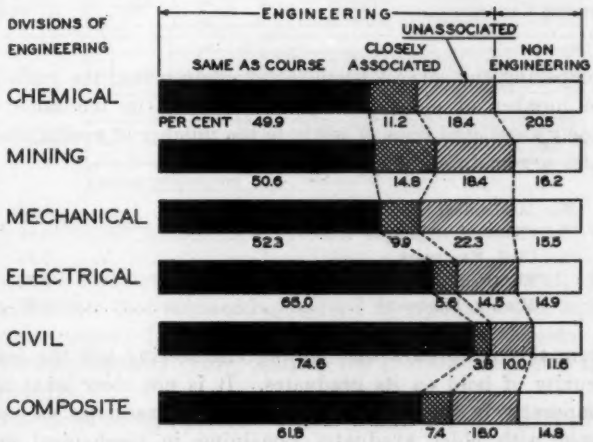


FIG. 1. Relationship of fields of work of engineering graduates to college courses.

These figures seem to disprove the statement so often heard that large proportions of graduates leave engineering for other activities. A comparison of the tabulations of recent and older graduates shows that there is some drift away from fields directly related to college courses, but not more than would seem to be entirely healthy. More civil engineering graduates remain in lines of work directly related to their college course than other groups of graduates. The percentages of

men in the same or closely associated fields are shown by the following figures:

PERCENTAGES OF GRADUATES IN THE SAME FIELDS AND THOSE CLOSELY ASSOCIATED WITH THEIR COLLEGE COURSES.

	Graduates of 1922, '23 and '24.	Graduates of 1919 and Earlier Classes.	Both Groups.
Civil Engineers	85.8	71.2	73.5
Electrical Engineers	80.3	56.7	70.6
Mining Engineers	74.6	50.0	65.4
Mechanical Engineers	62.0	62.5	62.1
Chemical Engineers	61.2	60.7	61.0

Comparing the several branches of engineering, the ratio of the number of older graduates remaining in the same or closely associated lines of work, to the number of recent graduates so remaining, is

For Mechanical Engineers	1.01
Chemical Engineers	0.99
Civil Engineers	0.83
Electrical Engineers	0.71
Mining Engineers	0.67

From this it appears that mining engineering has the least security of hold on its graduates. It is not clear what the comparatively small proportion of recent graduates as compared with older graduates remaining in mechanical and chemical engineering may mean; whether there is temporarily a smaller demand in those fields or a larger demand in others.

Types of Positions Occupied.—Tables 4 and 5 and Fig. 2 show the types of positions, or kinds of work, of engineering graduates. Of the recent graduates, 59.6 per cent are in technical engineering, 11.5 per cent are in research and teaching, 16.2 per cent in sales and administrative work, and 12.7 per cent in clerical, manual or miscellaneous types of work. Of the older graduates, 22.5 per cent are in strictly technical work, 10.1 per cent in research and teaching (note the slight

change from recent graduates), 63.9 per cent are in ownership, executive, and administrative work including sales, and 3.5 per cent are in clerical and miscellaneous types of employment. These figures show a healthy progression through

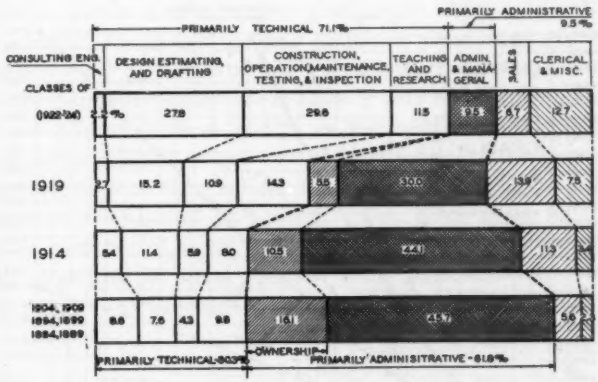
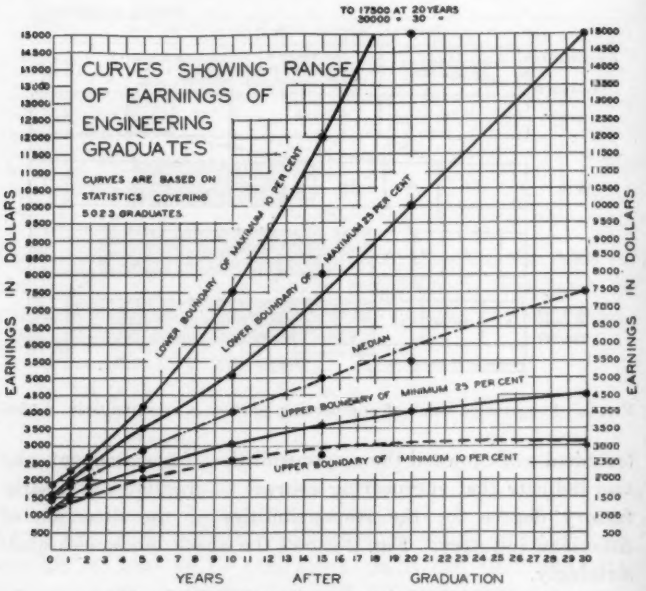


FIG. 2. Progressive trend of engineering graduates to managerial duties.

technical work toward the responsibilities of management, and also indicate that engineering courses fit graduates to a satisfactory degree for the responsibilities of the direction of American industry. Fig. 2 shows the above tendencies quite strikingly.

Earnings of Graduates.—Tables 6 and 7 and Fig. 3 give the earnings of engineering graduates as determined from figures supplied by the graduates themselves. It is to be remembered that data upon which the figures and tables are based were supplied by approximately one-half of those canvassed in the recent classes and approximately one-third in the older classes. Question may therefore be raised as to the accuracy of the figures. In order to determine their accuracy as nearly as possible, a number of checks were applied. One was the tabulation of a proportion of the replies and a comparison of the results with those for all replies. No significant differences were found, figures for all of the men replying being al-

most exactly the same as those for the first random 25 per cent. Figures submitted by colleges which obtained a high percentage of responses were then compared with those which obtained a small percentage. Again no significant differences


TO 17500 AT 20 YEARS
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CURVES SHOWING RANGE OF EARNINGS OF ENGINEERING GRADUATES
CURVES ARE BASED ON STATISTICS COVERING 5023 GRADUATES
LOWER BOUNDARY OF MAXIMUM 10 PER CENT
LOWER BOUNDARY OF MAXIMUM 25 PER CENT
MEDIAN
UPPER BOUNDARY OF MINIMUM 25 PER CENT
UPPER BOUNDARY OF MINIMUM 10 PER CENT
EARNINGS IN DOLLARS
EARNINGS IN DOLLARS
YEARS AFTER GRADUATION

FIG. 3. Earnings of engineering graduates.

were found, though the percentage of responses varied from as many as sixty-six to as few as twenty. Finally the results of this study were compared with a study of earnings made by Eta Kappa Nu, an honorary society of electrical engineering students and graduates (See BULLETIN No. 8 of this series). In the fraternity's study, approximately sixty-three per cent of those canvassed supplied data. The results of the two studies agree quite closely as to median and average curves. The distributions of earnings are also found to follow probability curves. In view of all available information it

seems probable that the figures given herein are substantially reliable and give a fair picture of the earnings of engineering graduates.

Beginning Salaries.—Table 6 shows a steady increase in salaries for the first year after graduation. It is interesting to compare the larger incomes of recent years with the decreased value of the dollar. For example, if we compare the median beginning salary of the class of 1914 or $800, with that of the class of 1924 or $1,476, on the basis of a sixty-three cent dollar in 1924 to par in 1914, we find that the present graduate is more than holding his own, the value of the 1914 salary on the basis of 1924 money values being about $1,270.

The earnings of recent graduates seem to increase steadily and satisfactorily, their progress being approximately $300 per year in annual salary, as shown by the following table:

	Median Earnings of Recent Graduates	
	Per Month.	Per Year.
Immediately after graduation	$123	$1,476
Six months after graduation	133	1,596
Twelve months after graduation	150	1,800
Twenty-four months after graduation	175	2,100

The progress of older graduates seems fair, though the rate of increase of the early years is not maintained.

There do not seem to be extreme variations between earnings of graduates of different institutions, certainly none greater than would be expected due to varying economic conditions of different parts of the country. Maximum and minimum median salaries of graduates at the beginning of 1925 reported by the various institutions are:

Class of 1924,	minimum	$110 per month,
	maximum	175 per month,
Class of 1923,	minimum	130 per month,
	maximum	219 per month,
Class of 1922,	minimum	140 per month,
	maximum	250 per month.

The Placement Process.—Tables 8, 9, 10, and 11 and Figs. 4, 5, and 6 give data and views obtained from recent graduates which bear upon the problems of placement and early adjustment in industry.

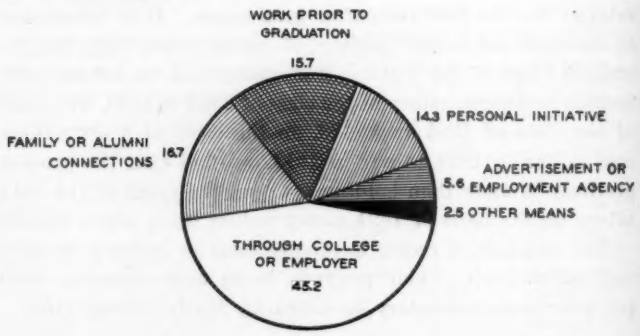

FIG. 4. Means through which engineering graduates obtain first positions.

Graduates in engineering obtained their first positions in the following manner: Through a teacher or other official of the colleges, 24.7 per cent; through the solicitation of an employer, 20.5 per cent; through work done prior to graduation, 15.7 per cent; through personal solicitation of employer by the graduates, 14.3 per cent; through family connections, 9.9 per cent; through alumni of the colleges, 6.8 per cent; through advertisement or employment agencies, 5.6 per cent; and by other means, 2.5 per cent. It will be noted that but 45.2 per cent of all the graduates obtained their first positions through the organized efforts of the colleges or employers.

Choice of First Position.—The reasons given by the graduates for their choice of first positions are as follows: Because the work was in direct line of their college course or closely associated with it, 49.5 per cent; apparent good opportunities, 25.8 per cent; only job available, 9.7 per cent; desired location, 8.7 per cent; good salary, 3.6 per cent; other reasons,

2.7 per cent. The desire for the right sort of experience or of opportunity was evidently of far more influence than all others, being 75.3 per cent of the total. Contrary to general impression, perhaps, the question of salary was ostensibly a very minor factor. The figures show an excellent demand for men of engineering training.

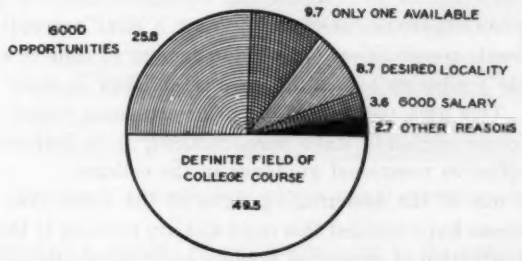

FIG. 5. Reasons for choice of first positions.

Shifting of Positions in Early Years.—The above relates to the first positions held. It is found that there is a very considerable shifting about from job to job among the recent graduates. Of the graduates of 1922, 57.0 per cent held two

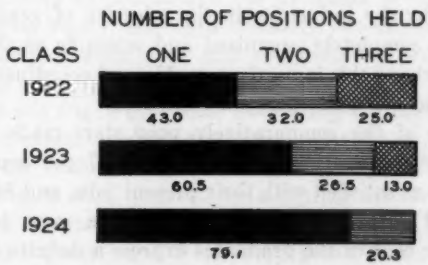

FIG. 6. Number of positions held since graduation.

or more positions and 25.0 per cent held three or more positions in the first two and one-half years after graduation. Of the class of 1923, 39.5 per cent similarly held two or more

positions, and 13.0 per cent held three or more in the first one and one-half years after graduation. Even in a class graduating as recently as 1924, about one-fifth held two or more positions in the first six months after graduation. These figures show an unwise choice of first positions in altogether too high a percentage of cases. Of the graduates who do change positions many do not remain long enough in the first job to gain much experience or even to obtain a clear conception of its ultimate possibilities. An undue amount of time is wasted by these graduates before they are established in their life's work. This high percentage of turnover among recent graduates could certainly have been reduced, it is believed, by more effective vocational guidance in the colleges.

It is one of the encouraging signs of the times that some institutions have realized this need and are meeting it through the introduction of personnel systems and the selection of personal advisers, either from among the faculty or individuals specially designated for the work. It is also significant that some colleges are providing means of giving to prospective graduates adequate information as to the various lines of work open to them. It must be admitted, however, that only a fair start has been made. It is also probably true that the methods employed by the industries in the selection of graduates are not yet as completely organized and scientific as they ought to be. Perhaps this is partly a problem of coordination of industrial and collegiate personnel methods.

In spite of the comparatively poor start made by many graduates, it is gratifying to note that 77 per cent express themselves as satisfied with their present jobs, and 81 per cent as satisfied with their prospects, but even more important, that 95 per cent of the graduates express a definite liking for engineering work and more of them, 98 per cent, feel that they made no mistake in taking an engineering course.

B. The Effectiveness of Engineering Courses

General Estimate of Effectiveness.—Tables 12 to 15 inclusive and Figs. 7 to 9 inclusive give the opinions of older

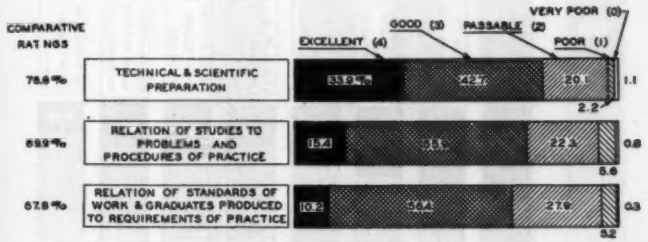

Fig. 7. Opinions of graduates as to effectiveness of engineering colleges.

graduates on a number of matters relating to the quality and effectiveness of the courses which they pursued in college.

Table 12 and Fig. 7 seem to indicate that graduates in general feel satisfied with their college courses. Over three-quarters believe that the technical and scientific preparation which they received for their life work was either good or excellent. About seventy per cent rate the relationship between the engineering subjects as taught and the problems of engineering practice equal highly, and approximately two-thirds feel that the standards of work done and of graduates produced by engineering colleges are either good or excellent.

Table 13 and Fig. 8 give some interesting indications of the manner and extent to which graduates believe their college experiences are valuable to them. The comparative scores shown in Fig. 8 were obtained by assigning arbitrary values of 0 to the designation "none," 1 to "little," 2 to "moderate," 3 to "great" and 4 to "very great." These values were multiplied by the percentages of replies which indicated each of them and the sum was then divided by the maximum assigned value, 4. The results give a rough indication of the comparative values which graduates assign to each of the several points and also indicate the order in which graduates

believe their experiences have been valuable. It will be noted that they rank *knowledge of fundamental principles of science* first, following this with *discipline in methods of thinking and*

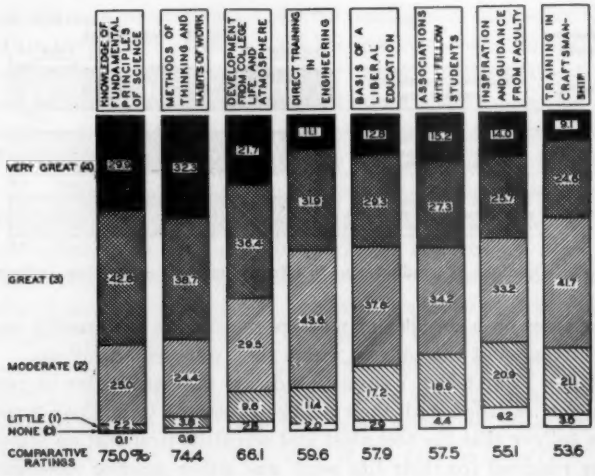

FIG. 8. Opinions of graduates as to value of college experiences.

habits of work, and that they place *training in craftsmanship* last.

Results Produced and Qualities Sought.—Tables 14 and 15 and Fig. 9 give the opinions of older graduates on the extent to which engineering courses are likely to produce certain results and also upon the qualities which they seek in younger engineers whom they employ. An arbitrary system of rating the results has been adopted similar to that explained above, the results being shown in Fig. 9. It will be noted—as might have been expected—that good character and qualities of leadership take first rank, and that graduates feel that development of qualities of leadership and powers of initiative and originality come last in rating the results of engineering courses.

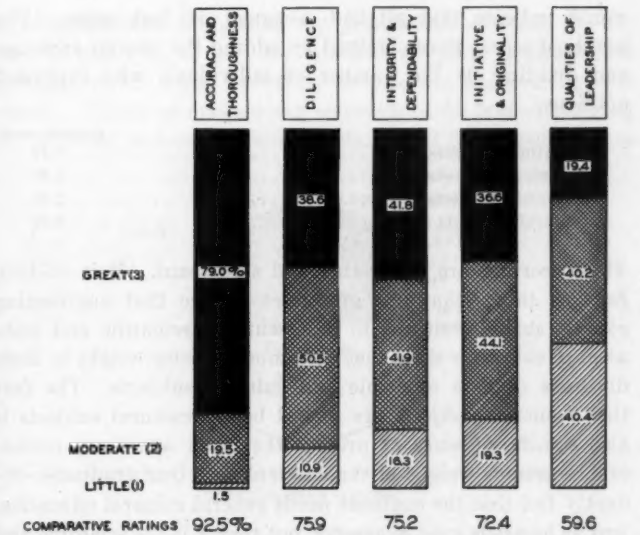

FIG. 9. Opinions of graduates as to extent engineering courses tend to develop certain characteristics.

Purposes of Engineering Curricula.—Opinions of graduates as to the objectives of engineering courses were expressed as follows:

To train broadly for the general needs of industry 20.6%
To train for the specific needs of specialized divisions of engineering practice 11.9%
To provide the former type of training for the majority and the latter for those who desire it 67.5%

The fact that so many hold this last idea indicates the need for serious effort to determine what provisions engineering colleges may make to that end.

The importance assigned by graduates to the various general divisions of curricula are indicated by the following tabulation. In this table a score of 1 would indicate that all graduates assigned a given division first place, and a score of 4

would indicate that all had assigned it last place. The weighted scores were obtained by adding the various rankings and dividing by the number of individuals who expressed opinions.

	Weighted Scores.
Scientific subjects	1.70
Technical subjects	1.80
Economic subjects	2.94
Cultural subjects	3.32

These scorings are interesting and significant. It is evident, for one thing, that our graduates believe that engineering courses should continue to be essentially scientific and technical in character since they give much greater weight to these divisions than to economic and cultural subjects. The fact that economic subjects are placed before cultural subjects is also significant since at present the latter are given considerably greater weight in the curriculum. Our graduates evidently feel that the engineer needs general cultural education, just as he needs good character, but that it is the scientific and technical part of his education which prepares him for engineering rather than for something else.

Value of Cultural Studies.—In connection with the matter of cultural studies in the engineering curriculum, recent graduates were asked to indicate by checking against a list of five items, the value which they assigned to the cultural studies which they pursued in college. The results were as indicated by the percentage of replies opposite each of the five following designations:

"Indispensable to my intellectual development"	24.5%
Considerable	32.5%
Sufficient to warrant time spent	28.6%
Not proportionate to time spent	4.0%
Negligible	10.4%

It is noteworthy that nearly sixty per cent indicated their belief that cultural studies were of "considerable" or greater value to them.

Modifications Suggested by Graduates.—Tables 16, 17, and 18 and Fig. 10 give the opinions of recent graduates on changes which might profitably be made in engineering curricula. The most outstanding criticism is the lack of training in business and economic subjects. Next in importance is

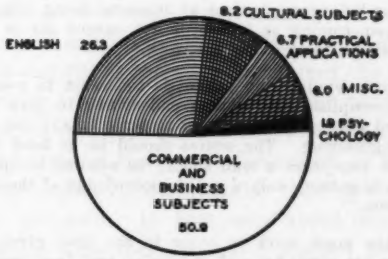

FIG. 10. Opinions of recent graduates as to important omissions from engineering courses.

the evident belief that more attention should be given to English. It is significant to note that only about one graduate in five replied to the question as to subjects considered unessential. Of those who did reply, more indicated modern foreign languages than any other one subject, with shop work second. It must be remembered, in this connection, that graduates of all courses expressed themselves and it is possible that those who indicated shop work as unessential were students of courses in which shop work is of minor importance.

Selected Comments of Graduates.—Each of the graduates was asked to contribute spontaneous suggestions as to desirable changes in engineering curricula. Many of these replies are interesting and some are valuable. A few have been selected as samples and appear below. No attempt has been made to choose the best answers, but rather to select typical ones.

"I consider that the field of greatest service of the University is in *vocational guidance* based on a thorough and scientific knowledge of

vocational psychology. To me, the greatest of all tragedies is 'the square peg in the round hole.' I know, for I have been one. The greatest work a college of engineering can do, in my estimation, is to study the man, his *inclinations* and native abilities and then start him right. A right start is a fortune in itself."

"Students should be given more explicit information in regard to the different branches of engineering. For example, I never knew the many departments in which an engineer may be employed until it was explained to me by representatives of concerns doing college recruiting. This information, coming as late as it did, caused me to make a hasty and unwise decision in choosing my work."

"The four-year engineering course is too short to accomplish all it purposes to accomplish. My course endeavored to give me a cultural background and also to fit me equally to serve in any one of the several branches of engineering. The course should be at least five years and during the last two years a man should be allowed to specialize in his chosen line, while gaining only a general knowledge of the other branches of the profession."

"There is too much work to cover in the time given, there is not enough opportunity given for self expression and development; too much emphasis is placed on grades given for academic information and not enough on character and application. Industry pays for character and the ability to accomplish and create."

"The theoretical and practical sides of engineering should be more closely linked in the college course (instead of studying theory then later on finding out what it's all about)."

"The course offered no advancement in the appreciation of the finer and 'cultural' things of life. Sufficient training in economics and administration was lacking. There was not sufficient personal contact between the student and the faculty."

"While I do not think college is the place to get practical experience, but rather to get a good technical foundation, I do think few of the instructors have had enough contact with industrial work to give the students a send off with the right point of view to fit in readily in industrial positions."

C. Continuation of Studies after Graduation

Proportion of Graduates Continuing Their Studies.—The data on this subject are enlightening and seem to give evidence of a considerable carrying on of the intellectual stimulus received in college. Tables 19 and 20 give information obtained from recent and older graduates in this connection. Among the older graduates a gratifying number, 13.7 per cent, con-

tinued graduate work in a college or university. (This figure is confirmed by statistics compiled by the United States Bureau of Education.) It is also significant to note that nearly one-quarter continued their education through extension, correspondence, or similar courses, or through regular courses of study given or supervised by employers. Assuming that there are few duplications among the men indicating these methods of continuing their education, it is evident that nearly three-eighths of those who answered the questionnaire continued their education through regular courses of study. The proportion who continued study more or less systematically as the nature of their work demanded, or who otherwise pursued some course of study under their own regulation, is over eighty per cent. In fact only about one-tenth of the graduates state that they have not studied along technical lines after leaving college. The participation of the colleges themselves in this work is small, however, being represented almost entirely by the group of men who pursued resident, graduate courses.

Educational Efforts of Recent Graduates.—Of the recent graduates the following facts are given: Approximately three-quarters of their positions were such as to require study; 56.6 per cent have studied along lines of their college courses, while 26.8 per cent have studied along lines not closely connected with their college work (a total of 83.4 per cent who have studied during the first two and one-half years after graduation). Over one-fourth reported that they have studied under the supervision of their employers, while nearly sixty per cent replied that they have studied independently of their employers' supervision and direction. A substantial and gratifying number, approximately forty-three per cent, reported that they had continued their interest in and study of cultural subjects.

In this connection it may be noted that the recent graduates were asked to state those subjects of a cultural nature in which they had continued interest after leaving college.

No definition of the word "cultural" was given, but each graduate listed his subjects of interest spontaneously. Economics, accounting, law, business administration, and other subjects connected with the business aspects of industry were mentioned most frequently. English literature, public speaking, and related subjects came next in order. Then followed

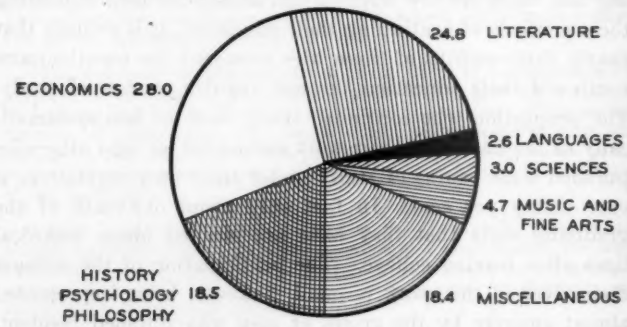

FIG. 11. Types of cultural interests of engineering graduates.

history, psychology, philosophy, political science, sociology, music, the fine arts, languages, various sciences, and a miscellaneous group including journalism, education and others. Over half of the mentions, however, were confined to commerce and business subjects and to English. This strong preponderance, taken in connection with answers to other questions, indicates that graduates feel very strongly that engineering curricula are deficient in the time and emphasis devoted to these subjects.

Significant Points.—The most significant points in the matter of the continuation of study by graduates seem to be, first, the large proportion who have continued their education, and second, the relatively small participation in this work by the colleges themselves. It is believed that engineering colleges may well give serious consideration to means of exercising greater influence over the intellectual life of their

graduates and of guiding and directing their studies in such a way as to insure a maximum result for the time and energy expended. This matter will be discussed more fully later.

D. Records of Non-Graduates

Data on Former Students.—As previously stated, the evidence on students who did not graduate is not sufficiently complete to warrant more than general observations; in fact, it is doubtful whether the group canvassed is representative of the general group of engineering students who do not complete their courses. For one thing, the average time these students remained in college was 3.7 semesters or 1.85 academic years. This is rather longer than the length of time spent in college by the average student who does not graduate. It seems probable that the questionnaire was answered by students who have maintained a greater interest in their college than the average non-graduating student has.

Tables 21 to 24 inclusive give most of the significant material gathered from the non-graduates who replied to the questionnaire. In studying these results, it should be remembered that other evidence not tabulated indicates that the non-graduating students enjoyed as good health as students who do graduate and, furthermore, that the amount of time which they devoted to college activities and self-support was, if anything, less than the time similarly devoted by students who do graduate. These factors, therefore, appear not to have had an abnormal influence on the scholastic careers of these men.

Reasons for Leaving College.—The predominant reasons for leaving college, or at least for leaving engineering, are scholastic failure, lack of interest, and voluntary change of course, these reasons combined being the cause of 42.6 per cent of the withdrawals. These students obviously were misplaced either because of lack of ability, aptitude, or interest. Financial difficulty was stated as the chief reason in 24.3 per cent of the cases. War service was cited by 11.7 per cent, this being, of course, an unusual reason. Other reasons were health, 8 per cent, change in status of family, 6.4 per cent, and mis-

cellaneous reasons, 7 per cent. It is rather interesting to note that the percentage of students who reported financial difficulty as the reason for leaving college, 24.3 per cent, is precisely the same as the number who reported complete dependence upon self-support during college, though it does not follow that these figures represent the same individuals. It is difficult to reconcile the statements that financial difficulty was a chief reason for leaving college in so many cases, since the percentage of self-supporting students, as before stated, is no greater in this special group than it is among engineering students in general. It may be that the non-graduating students have unconsciously overemphasized this factor.

Of the causes of scholastic difficulty into which detailed inquiry was made, it appears that 55.6 per cent of the men acknowledged their difficulty to have been either poor preparation, carelessness or neglect, or lack of interest. It may be noted that figures obtained from college records indicate that 69.4 per cent of scholastic failures are attributable to these causes. The difference between these two figures, while not large, may be due to the difference in point of view of the two groups, the students on the one hand and the college authorities on the other. The blame was put by the former students on the school or on the teachers in 23.2 per cent of the cases. The cause of the failure of 10 per cent more was given as the outside demands on their time, such as necessity for self-support. Contrary to the usual opinion, at least in the minds of the non-graduates themselves, social diversions, athletics, and college activities played a very minor part in the failures.

PART II. CONCLUSIONS AND RECOMMENDATIONS OF THE COMMITTEE

It is recognized that the field of study in connection with problems of engineering graduates is a very broad one. It is not within the bounds of practicability to consider all problems within that field at present. Attention has therefore been concentrated upon the following specific issues which it is believed should receive the early and earnest attention of engineering colleges:

A. Guidance of graduates in choosing fields of work and first positions.

B. Assistance in the continuation of study after leaving college.

A. Guidance of Graduates in Choosing Fields of Work and First Positions

Evidences of the Need.—"I consider that the field of greatest service of a university is in *vocational guidance* based on a thorough and scientific understanding of vocational psychology. To me the greatest of all tragedies is 'the square peg in the round hole.' I know for I have been one. The greatest work that a college of engineering can do, in my estimation, is to study the man, his inclinations and native abilities, and start him right. A right start is a fortune in itself."

This answer to one of the questions put to engineering graduates is expressive because of its terseness. It has been widely quoted and while the words are those of only one man, they seem to express a thought in the minds of a great many graduates. The very considerable shifting from position to position during the first year or so after graduation is evidence of the genuine need for constructive work in this field. While a certain amount of shifting is inevitable and in some cases desirable, it seems probable that these figures show that an undue amount of time is wasted by too large a proportion of graduates before getting definitely settled. Evidently too many graduates choose positions for which they are not fitted. Apparently engineering colleges and the industries, jointly, must contribute to the solution of this problem.

Problem of Choice Among Functional Types of Activity.—The question of what to do with an engineering education after it has been obtained is just as important as the decision to go to college to acquire it. As the senior approaches the time to leave college and get started in his profession, he finds himself confronted with the problem of making a choice among types of work described in somewhat different terms from those to which he has been accustomed. It is no longer suf-

ficient for him to say that he will follow electrical engineering or mechanical engineering. He finds the emphasis of prospective employers based to a considerable extent upon an entirely different classification of engineering work. He finds, for example, that industry is less inclined to emphasize differences between electrical engineering and mechanical engineering than it is to emphasize the distinction between the engineering of research or design and the engineering of operation or management. The prospective graduate, therefore, finds himself called upon to make a decision as to which of the *several engineering functions* he will follow. Engineering curricula are not differentiated in accordance with these functional divisions, nor, in general, is any particular effort made to develop students as research engineers, design engineers, operating engineers or sales engineers. In fact, the graduate has had little opportunity in his college course to obtain a clear conception of the several functional divisions of engineering open to him.

It has been suggested that curricula might well be differentiated in accordance with these functional divisions. (See "Engineering Courses for the Functional rather than the Industrial Divisions of Engineering" by Edward Bennett; ENGINEERING EDUCATION, June 1924). If this were done one of the ends served would be effectively to orient the student to one particular functional division and doubtless also to acquaint him with the characteristics of others. This proposal is of such importance, however, as to require greater space for adequate treatment than is here afforded. These comments will therefore be confined to curricula and methods as found at present.

The Normal Path of Progress.—Detailed figures showing the distribution of engineering graduates among the several fields of design, operation and maintenance, research, sales, management, etc., are given in Tables 4 and 5. These figures show not only the various lines of work and functional divisions of engineering into which graduates go upon leaving college, but also the progressive trends from some types of ac-

tivity to others. It is shown clearly, for example, that a majority of the graduates are employed in their earlier years in the more definitely technical types of work while the older graduates are engaged in work which is primarily of an administrative nature.

It is obvious that this should be the normal path for engineering graduates to follow in their progress to responsible positions. It is doubtful, however, if the prospective graduate has any clear conception of this and other important matters bearing upon his future. In particular, as above stated, it is doubtful if he visualizes the differences between the several functional divisions previously mentioned. Probably in a majority of cases the student has given little serious study to the particular type of activity for which he is best suited, in fact he generally lacks the knowledge of the situation upon which to base such study.

Summary of the Problem and of Means of Betterment.—The problem of the vocational guidance of engineering graduates seems, therefore, to resolve itself into one of finding ways and means of giving the prospective graduate a conception of the functional or vocational arrangement of engineering work as it actually exists and of providing means whereby he may be brought to think of himself, his instincts, tastes, personality, ability, etc., in terms of the requirements for successful work in these several functions.

Some of the possible means of accomplishing this objective embrace the following:

A. The presentation of a well organized series of lectures to all seniors in which industry would cooperate by supplying speakers competent to give a clear picture of the nature of the work and opportunities in their respective fields. One lecture of such a series might well include the facts as to lines of employment of recent and older graduates presented herein. These data lend themselves to diagrammatic presentation and can be shown by lantern slides.

B. Better organization of the time and efforts of employment representatives when visiting colleges so as to conflict least with classes during the recruiting periods. Assistance might also be given the representatives in the determination of those seniors best adapted to the work in each specific industry.

C. In order that all possible information may be available in aiding both the graduate and the industry in wise selection, it would be advisable for colleges to maintain personnel record of all their students. These would be of considerable educational value and would be particularly helpful in connection with employment. A representative of industry indicates that employers would be interested in the following data:

1. To identify the student.
   (*a*) Name.
   (*b*) Home address.
   (*c*) College address and telephone number.
   (*d*) Age, height and weight.

2. To indicate the influence of heredity and home environment.
   (*a*) Parents' education, occupation and nationality.
   (*b*) Church affiliations.

3. To indicate educational attainment and grade of mentality.
   (*a*) Preparatory or high school scholastic records and name of school.
   (*b*) Recommendation of preparatory or high school principal before entering college.
   (*c*) College scholastic record including all honors and special recognitions.
   (*d*) Name of intelligence test and rating of the student (if tests are given).
   (*e*) Chronological record of personal conferences with the student including reasons therefore, recommendations made, and if possible, the effect.

4. To indicate physical condition and capacity for leadership.
   (*a*) Record of physical examinations. Defects and doctors' recommendations, both upon entering college and at the beginning of the senior year.
   (*b*) Record of participation in college activities.
   (*c*) Record of athletic activities.
   (*d*) R. O. T. C. or military record.
   (*e*) Membership in professional societies.

5. To indicate previous experience and degree of dependence.
   (*a*) Positions held, name of employer, type of work, with dates.
   (*b*) Portion of college expenses earned.

6. To indicate effect of the above influences in the development of personal characteristics. Ratings by the dean, department head, or individual members of the faculty on—
   (*a*) Personal appearance.
   (*b*) Culture.
   (*c*) Mentality.
   (*d*) Leadership.
   (*e*) Reliability.
   (*f*) Capacity for growth.

7. To indicate the student's aptitude for particular fields of endeavor.
   (*a*) A statement from the student as to what he feels he would like to do and could be most successful in, giving reasons wherever possible.
   (*b*) Statement of the dean or department head of his opinion as to what field of endeavor the student should enter, with reasons.

B. Continuation of Education after Leaving College

Why Needed?—As the purpose of engineering education is to give a training in certain fundamental principles and methods and some acquaintance with their application to problems of practice, the student naturally has very little opportunity in the undergraduate program to deal with actual engineering problems and acquires little or no real conception either of engineering as a whole or of any of its divisions. The first two years after graduation may be likened to the period of internship of the young physician. Young engineers, however, do not spend their probationary period under conditions of uniformly close supervision, but rather under the widest diversity of conditions. That this should be the case seems entirely reasonable and accords with the tremendous breadth of the engineering field, the great multiplicity of its technical divisions, and the range of functional activities of engineers.

Recognizing that a college course does not complete an engineering education, industrial concerns which employ large numbers of recent graduates have instituted systematic post-scholastic training programs with the purpose of initiation to engineering work and of orientation to the industry itself. A considerable number of graduates enroll in these courses as

post-graduate students for the purpose of further training; some without intending to remain permanently in the employing organization.

It is hardly thinkable that the colleges would desire to supersede these efforts, essentially recognized as an industrial responsibility in that the industry's efforts are largely directed toward the training of employees for its particular work. It must be remembered, however, that such courses are practicable only as activities of the larger organizations. Futhermore, they cannot provide for more than a minority of graduates and they cannot provide equally for the graduates of all courses.

That the graduates themselves realize that their college courses are not designed to provide a complete engineering education is apparent from the data presented herein. Referring to the tables, it will be found that only a small fraction of the graduates replying stated that they had not more or less systematically pursued some course of study. It is also to be noted that about one-fourth of the graduates replied that such study had been advised or supervised by employers and that three-fourths of the positions occupied were such as to require a continuation of education begun in college. It may also be pertinent to mention the considerable enrollment of engineering graduates in correspondence courses, particularly those of a general business character.

Responsibilities of the Colleges.—All of the foregoing is mentioned to substantiate the belief that the time is ripe for the colleges to consider ways and means of assisting graduates in educational work after leaving college. It is worthy of note that in the year 1925–26 upwards of 1,100 students were pursuing graduate courses in engineering, this number representing about one-eighth of the number receiving first degrees in the previous year. It is gratifying that this number is so large and it is probable that provision for such work should be even more extensive, provided always that it is kept on a high plane and that enthusiasm does not lead to the establishment of graduate courses without adequate teaching per-

sonnel and facilities. The mere provision of graduate courses, however, does not entirely meet the situation. As previously stated, it is both necessary and desirable that a majority of graduates should begin productive work in actual practice immediately upon completion of their undergraduate courses.

Methods of Meeting the Need.—There appears to be a distinct, though undeveloped field of opportunity for the colleges to assist these young men in extending their education. As possible means to these ends, the following suggestions are offered:

1. The colleges may make well-outlined reading courses available to such graduates as apply for them.
2. Certain institutions, if properly manned and organized, may offer correspondence courses. Subjects such as contracts and specifications; industrial organization and planning; commercial methods, organizations and law; cost accounting; and financial methods lend themselves to instruction by this means.
3. In certain cases extension courses such as those given by the University of Wisconsin for graduate students in Milwaukee may be set up in industrial centers in which graduates in particular fields can confer with representatives of the institutions at regular intervals. Post-scholastic courses of the following types may be offered:
   - (*a*) Advanced work of the kind given in post-graduate residence courses in mathematics, physics and engineering subjects.
   - (*b*) Courses dealing with recent developments, designed to enable graduates to keep abreast of scientific progress.
   - (*c*) Seminars for the discussion in the light of fundamental theory of
     - (1) Allied research problems,
     - (2) Design problems,
     - (3) Operating problems.

4. The engineering colleges may individually undertake to furnish advisory services to alumni and other engineers in the vicinity of the colleges to assist in such matters as:
   (*a*) Recommended reading courses.
   (*b*) Supplying of information as to educational facilities available in the community in which the graduate is located.
   (*c*) Advice and suggestions relative to engineering problems of the kind rendered to students in residence who are engaged in thesis projects.

It is recognized that there are limitations imposed by the budget and that different institutions will find different methods possible or serviceable. The present purpose, however, is to call attention to the opportunity and need for work among the graduates and to affirm the belief that no other undeveloped activity of the engineering colleges offers larger possibilities for increased service.

PART III. TABULAR SUMMARY OF DATA

(Based on 3,933 graduates of 43 institutions in the classes of 1922, 1923, and 1924; 2,336 graduates of 34 institutions in the classes of 1919, 1914, and earlier, at five year intervals; and 721 non-graduate former students of 14 institutions and of the classes of 1924, 1919, 1914, 1909, and 1904.)

1. FIELDS OF WORK OF OLDER GRADUATES.

		Classes of					Totals.
		1919.	1914.	1904, 1909.	1894, 1899.	1884, 1889.	
Industrial	No.	158	276	363	164	24	985
	%	*35.3*	*45.9*	*43.5*	*40.7*	*23.8*	*41.3*
Commercial	No.	80	86	136	68	17	387
	%	*18.2*	*14.3*	*16.3*	*16.8*	*16.8*	*16.3*
Financial	No.	35	20	39	12	2	108
	%	*7.9*	*3.3*	*4.7*	*3.0*	*2.0*	*4.5*
Professional	No.	114	136	195	108	42	595
	%	*25.9*	*22.7*	*23.3*	*26.8*	*41.6*	*25.0*
Governmental—Others	No.	54	83	102	51	16	306
	%	*12.2*	*13.8*	*12.2*	*12.7*	*15.8*	*12.9*

2. Relationship of Fields of Work of Recent Graduates to College Courses.

Courses Graduated From.		Present Fields of Work.				Totals.
		Engineering.			Non-Engineering Field.	
		Same Field.	Closely Associated Field.	Unassociated Field.		
Chemical Engineering	No.	210	47	70	93	420
	%	*50.0*	*11.2*	*16.6*	*22.2*	
Civil Engineering	No.	609	18	59	45	731
	%	*83.3*	*2.5*	*8.1*	*6.1*	
Electrical Engineering	No.	672	44	85	91	892
	%	*75.3*	*5.0*	*9.5*	*10.2*	
Mechanical Engineering	No.	515	89	238	131	973
	%	*52.9*	*9.1*	*24.5*	*13.5*	
Mining Engineering	No.	96	33	23	21	173
	%	*55.5*	*19.1*	*13.3*	*12.1*	
Totals	No.	2,102	231	475	381	3,189
	%	*66.0*	*7.2*	*14.9*	*11.9*	

3. Relationship of Fields of Work of Older Graduates to College Courses.

Courses Graduated From.		Present Fields of Work.				Totals.
		Engineering.			Non-Engineering Field.	
		Same Field.	Closely Associated Field.	Unassociated Field.		
Chemical Engineering	No.	69	16	33	22	140
	%	*49.3*	*11.4*	*23.6*	*15.7*	
Civil Engineering	No.	494	39	90	126	749
	%	*66.0*	*5.2*	*12.0*	*16.8*	
Electrical Engineering	No.	309	41	133	134	617
	%	*50.0*	*6.7*	*21.6*	*21.7*	
Mechanical Engineering	No.	292	63	104	109	568
	%	*51.4*	*11.1*	*18.3*	*19.2*	
Mining Engineering	No.	44	8	28	24	104
	%	*42.3*	*7.7*	*26.9*	*23.1*	
Totals	No.	1,208	167	388	415	2,178
	%	*55.5*	*7.7*	*17.8*	*19.0*	

4. Types of Positions Held by Recent Graduates as of January 1, 1925.

(Secondary as well as primary aspects of positions are included.)

	Number.	Per Cent.	
Construction	642	10.1	
Design	681	10.7	
Testing	662	10.4	
Estimating	577	8.9	
Drafting	519	8.2	
Operation and Maintenance	580	9.1	
Consulting Engineering	138	2.2	
		—	59.6
Research	482	7.7	
Teaching	238	3.8	
		—	11.5
Administration	605	9.5	
Sales	428	6.7	
		—	16.2
Clerical	338	5.3	
Manual	121	1.9	
		—	7.2
Others	351	5.5	
		—	5.5
			100.0

5. Types of Positions of Older Graduates.

		Classes.										Totals.
		1919.		1914.		1904 and 1909.		1894 and 1899.		1884 and 1880.		
Consulting Engineering	No.	12		34		55		44		18		163
	%	2.7		5.4		6.5		10.2		18.8		6.7
Design	No.	37		44		47		24		5		157
	%	8.4		7.0		5.6		5.6		5.2		6.4
Estimating	No.	20		21		11		5		3		60
	%	4.5		3.4		1.3		1.2		3.1		2.5
Drafting	No.	10		6		4		5				25
	%	2.3		1.0		0.5		1.2				1.0
Operation & Maintenance	No.	20		24		23		22		1		90
	%	4.5		3.8		2.7		5.1		1.0		3.7
Testing & Inspection	No.	28		13		5		5		2		53
	%	6.4		2.1		0.6		1.2		2.1		2.2
			28.8		22.7		17.2		24.5		30.2	
Research	No.	30		26		23		18		1		98
	%	6.8		4.2		2.7		4.2		1.0		4.0
Teaching	No.	33		23		61		24		7		148
	%	7.5		3.8		7.2		5.6		7.3		6.1
			14.3		8.0		9.9		9.8		8.3	
Owner or Proprietor	No.	24		66		121		81		19		311
	%	5.5		10.5		14.4		18.8		19.8		12.8
Executive & Administrative	No.	54		130		228		113		23		548
	%	12.3		20.7		27.1		26.3		24.0		22.5
Management	No.	25		64		79		32		7		207
	%	5.7		10.2		9.4		7.4		7.3		8.5
Superintendence	No.	53		83		105		33		5		279
	%	12.0		13.2		12.5		7.7		5.2		11.5
Sales	No.	61		71		58		15		4		209
	%	13.9		11.3		6.9		3.5		4.2		8.6
			49.4		65.9		70.3		63.7		60.5	
Clerical	No.	6		4		2		1				13
	%	1.4		0.7		0.2		0.2				0.5
Miscellaneous	No.	26		17		20		8		1		72
	%	6.1		2.7		2.4		1.8		1.0		3.0
			7.5		3.4		2.6		2.0		1.0	
Totals		439	100.0	626	100.0	842	100.0	430	100.0	96	100.0	2,433

6. Earnings of Engineering Graduates.

Class of		Years After Graduation.								
		0.	1.	2.	3.	5.	10.	15.	20.	30.
1924..	Number Reporting	1,191								
	Median Annual Earnings	*$1,476*								
1923..	Number Reporting	1,331	1,218							
	Median Annual Earnings	*$1,440*	*$1,800*							
1922..	Number Reporting	1,149	1,082	1,023						
	Median Annual Earnings	*$1,320*	*$1,800*	*$2,100*						
1919..	Number Reporting	319	319	304	274	309				
	Median Annual Earnings	*$1,300*	*$1,800*	*$2,000*	*$2,200*	*$2,860*				
1914..	Number Reporting	496	475	458	436	444	498			
	Median Annual Earnings	*$ 800*	*$1,000*	*$1,200*	*$1,600*	*$2,400*	*$4,000*			
1909..	Number Reporting	459	418	414	404	416	422	430		
	Median Annual Earnings	*$ 720*	*$ 900*	*$1,200*	*$1,366*	*$1,800*	*$3,000*	*$5,000*		
1904..	Number Reporting	243	223	221	212	202	226	216	238	
	Median Annual Earnings	*$ 720*	*$ 900*	*$1,200*	*$1,300*	*$1,530*	*$2,500*	*$4,000*	*$5,500*	
1899..	Number Reporting	156	126	125	123	125	130	129	147	
	Median Annual Earnings	*$ 600*	*$ 800*	*$1,075*	*$1,380*	*$1,600*	*$2,700*	*$4,000*	*$6,000*	
1894..	Number Reporting	119	97	96	92	109	102	103	100	116
	Median Annual Earnings	*$ 600*	*$ 900*	*$1,000*	*$1,200*	*$1,500*	*$2,400*	*$3,600*	*$5,000*	*$7,500*

7. ANALYSIS OF EARNINGS OF ENGINEERING GRADUATES AS OF JUNE 1, 1924.

Class.	Years Since Graduation.	Number Reporting.	Annual Earnings in Dollars.							
			Minimum.	Limit of Lowest 10%.	Limit of Lowest 25%.	Median.	Limit of Highest 25%.	Limit of Highest 10%.	Maximum.	Most Frequent.
1924	0*	1,191	300	1,200	1,200	1,476	1,560	1,860	4,080	1,200
1923	1	1,218	420	1,404	1,560	1,800	1,980	2,280	5,100	1,800
1922	2	1,023	360	1,560	1,800	2,100	2,400	2,640	9,000	1,800
1919	5	309	1,500	2,100	2,400	2,860	3,500	4,200	25,000	3,000
1914	10	498	1,200	2,600	3,110	4,000	5,100	7,500	50,000	5,000
1909	15	430	1,700	2,700	3,600	5,000	8,000	12,000	49,500	6,000
1904	20	238	1,920	3,290	4,000	5,500	10,000	15,000	90,000	4,000
1894	30	116	1,980	3,000	4,500	7,500	15,000	30,000	100,000	6,000
	Total	5,023								

* Beginning salary.

8. MEANS THROUGH WHICH RECENT GRADUATES OBTAINED FIRST POSITIONS.

(Some graduates indicated more than one means.)

	Number.	Per Cent.	Total Per Cent.
Through the college or a member of the faculty	959	24.7	
Through solicitation by employer	797	20.5	45.2
Through connection formed or work done before graduation	608	15.7	15.7
Through an advertisement	136	3.5	
Through an employment agency	81	2.1	5.6
Through family connection	386	9.9	
Through alumni of the college	266	6.8	16.7
Through personal solicitation or other endeavor of the graduate	556	14.3	14.3
By other means	97	2.5	2.5
	3,886		100.0

9. Reasons Given by Recent Graduates for Choice of First Positions.

(Some graduates gave more than one reason.)

	Number.	Per Cent.	Total Per Cent.
Position was in definite field of college course..	798	19.4	
Position was in general field of college course...	1,234	30.1	
			49.5
Position seemed to offer good opportunities....	1,058	25.8	
			25.8
Position was in desired locality.....	358	8.7	
Good salary.....	149	3.6	
			12.3
Only position available.....	399	9.7	9.7
Other reasons.....	113	2.7	2.7
	4,109		100.0

10. Number of Positions Held Since Graduation.

		Classes of			Totals.
		1922.	1923.	1924.	
One position.....	No.	542	835	988	2,365
	%	*43.0*	*60.5*	*79.7*	*61.0*
Two positions.....	No.	403	365	252	1,020
	%	*32.0*	*26.5*	*20.3*	*26.3*
Three positions.....	No.	315	179		494
	%	*25.0*	*13.0*		*12.7*
Total number reporting		1,260	1,379	1,240	3,879

11. Reactions of Recent Graduates to Present Positions, Prospects, Etc.

	Number.	Per Cent.
Satisfied with positions	2,643	76.9
Dissatisfied with positions	794	23.1
Satisfied with prospects	2,880	81.0
Dissatisfied with prospects	676	19.0
Like engineering work	3,241	95.4
Dislike engineering work	155	4.6
"Glad I studied engineering"	3,564	97.7
"Sorry I studied engineering"	83	2.3

12. Opinions of Older Graduates as to Effectiveness of Engineering Courses.

		Excellent.	Good.	Passable.	Poor.	Very Poor.
Quality of technical and scientific preparation for life work	No.	606	763	360	40	20
	%	*33.9*	*42.7*	*20.1*	*2.2*	*1.1*
Relationship between college subjects and problems and procedures of practice	No.	280	1016	406	101	15
	%	*15.4*	*55.9*	*22.3*	*5.6*	*0.8*
Standards of work done and graduates produced by engineering colleges	No.	182	1001	495	92	6
	%	*10.2*	*56.4*	*27.9*	*5.2*	*0.3*

13. Opinions of Older Graduates as to the Value of their College Experiences.

		Very Great.	Great.	Moderate.	Little.	None.
Knowledge of the fundamental principles of science	No.	616	884	515	46	3
	%	29.9	42.8	25.0	2.2	0.1
Discipline in methods of thinking and habits of work	No.	662	793	499	77	16
	%	32.3	38.7	24.4	3.8	0.8
General development derived from college life and atmosphere	No.	393	661	536	175	50
	%	21.7	36.4	29.5	9.6	2.8
Direct preparation for engineering work	No.	219	630	861	226	39
	%	11.1	31.9	43.6	11.4	2.0
Acquirement of the basis of a liberal education	No.	247	569	732	334	56
	%	12.8	29.3	37.8	17.2	2.9
Associations and friendships formed with fellow students	No.	294	530	664	366	85
	%	15.2	27.3	34.2	18.9	4.4
Inspiration and guidance derived from members of the faculty	No.	274	504	651	411	122
	%	14.0	25.7	33.2	20.9	6.2
Training in craftsmanship	No.	170	461	783	397	65
	%	9.1	24.6	41.7	21.1	3.5

14. Expressions of Opinion of Older Graduates as to the Extent Engineering Courses are Likely to Produce Certain Results.

		Great.	Moderate.	Little.
Develop habits of accuracy and thoroughness....	No.	1,335	330	25
	%	*79.0*	*19.5*	*1.5*
Develop diligence.....	No.	613	801	173
	%	*38.6*	*50.5*	*10.9*
Develop qualities of integrity and dependability..	No.	677	679	263
	%	*41.8*	*41.9*	*16.3*
Develop powers of initiative and originality.....	No.	592	715	312
	%	*36.6*	*44.1*	*19.3*
Develop qualities of leadership.....	No.	310	644	648
	%	*19.4*	*40.2*	*40.4*

15. Qualities Sought by Engineers in Other Engineers whom They Employ.

(A score of 1 would indicate that all graduates assigned a given quality first place, and a score of 5 would indicate that all graduates assigned a given quality fifth place. The average scores were obtained by adding the various rankings and dividing by the number of individuals who gave opinions.)

Average Score, or Order of Importance.	Quality.		Relative Weight.		
			Great.	Moderate.	Little.
1.74	Character.....	No.	806	195	18
		%	*79.1*	*19.1*	*1.8*
2.06	Leadership.....	No.	782	208	40
		%	*75.9*	*20.2*	*3.9*
3.27	Training in a particular course or specialty.....	No.	259	513	228
		%	*25.9*	*51.3*	*22.8*
3.31	Physical qualities.....	No.	229	690	83
		%	*22.9*	*68.8*	*8.3*
4.02	Scholastic record.....	No.	78	529	372
		%	*8.0*	*54.1*	*37.9*

16. Opinions Given by Recent Graduates as to Important Omissions from Their College Courses.

	Number.	Per Cent.	Total Per Cent.
Commercial and business subjects	595	30.9	
Economics, engineering economics	202	10.5	
Business law	59	3.1	
Industrial management, labor problems	32	1.7	
Salesmanship	49	2.5	
Accounting, cost keeping, estimating	42	2.2	
			50.9
English	334	17.4	
Public speaking	150	7.8	
Business English, technical English	22	1.1	
			26.3
Cultural subjects	133	6.9	
Languages	25	1.3	
			8.2
Practical applications	128		6.7
Psychology	37		1.9
Miscellaneous	115		6.0
	1,923		100.0

17. Subjects which Recent Graduates Consider Unessential.

	Number.	Per Cent
Modern languages	170	21.9
Shop work	94	12.1
Descriptive geometry	55	7.1
Military training	21	2.7
Miscellaneous—All other recommendations are so scattering as not to be significant	435	56.2
	775	100.0

Many graduates in answering this question stated that they considered all subjects essential. Others left the answer blank, possibly indicating that they were unable to select any subject as unessential.

18. Opinions of Recent Graduates as to Improvements in Engineering Courses.

	Number.	Per Cent.	Total Per Cent.
Give business training	134	15.4	
Give more or better engineering economics	6	0.7	
Give more or better general economics	11	1.3	
Teach administrative and executive work	1	0.1	
Teach salesmanship	1	0.1	
			17.6
Lengthen all engineering courses	154		17.7
Give more English, teach public speaking	52		6.0
Give more cultural work, or give it better	138		15.9
Give more practical training	99	11.4	
Use summer vacations for practical work	21	2.4	
Give orientation courses for seniors	11	1.3	
Give students early contact with industry	14	1.6	
Take inspection trips	9	1.0	
			17.7
More or better teachers	17		1.9
More or better teaching of the sciences	43	5.0	
Raise standards of work	12	1.4	
Coordinate the various courses better	3	0.3	
			6.7
Less specialization, more electives	110		12.7
Miscellaneous	33		3.8
	869		100.0

19. Study Done by Recent Graduates Since Graduation.

	Number.	Per Cent of those Canvassed.
Positions which require study	2,909	74.0
Positions which do not require study	887	22.5
Number not replying	137	3.5
Study along lines of college course	2,222	56.6
Study not along lines of college course	1,059	26.8
Number not replying	652	16.6
Study supervised by employers	1,105	28.1
Study not supervised by employers	2,255	57.3
Number not replying	573	14.6
Continued interest in and study of cultural subjects	1,693	43.1
Interest in and study of cultural subjects not continued	1,346	34.2
Number not replying	894	22.7

Many of the 3,933 graduates canvassed, indicated more than one method of continuing their studies.

20. Statements of Older Graduates as to Continuation of Technical Education Since Graduation.

(The number of graduates canvassed was 2,336. Many of them indicated more than one method of continuing their technical education.)

	Number.	Per Cent. of Those Canvassed.
Graduate work in a college or university	320	13.7
Extension, correspondence, or similar courses	367	15.7
Courses given, supervised or required by employers	180	7.7
Systematic, self-regulated study	445	19.1
Such unsystematic study as work has demanded	1,464	62.8
Other varieties of study	146	6.3
No study along technical lines	242	10.4

21. Reasons Given by Non-Graduates for Leaving College.

	Number.	Per Cent.
Financial difficulty	219	24.3
Scholastic failure	205	22.7
Lack of interest in engineering	89	9.9
Voluntary change of course	90	10.0
War service	106	11.7
Health	72	8.0
Change in status of family	58	6.4
Other reasons	63	7.0

22. Causes of Scholastic Difficulty of Non-Graduates.

	Number.	Per Cent.	Total Per Cent.
Poor preparation	98	18.2	
Carelessness or neglect on part of student	115	21.4	
Lack of interest or aptitude for engineering	86	16.0	
			55.6
Poor arrangement of course	71	13.2	
Poor presentation of subjects	54	10.0	
			23.2
Self-support	39	7.2	
Time spent in commuting	15	2.8	
			10.0
Social diversions	23	4.3	
Athletics	10	1.9	
Other college activities	5	1.3	
			7.5
Other reasons	20		3.7
			100.0

23. SUBJECTS IN WHICH NON-GRADUATES HAD MOST DIFFICULTY.

	Number.	Per Cent.
Mathematics	204	21.4
Chemistry	155	16.3
Modern languages	120	12.6
Descriptive geometry and drawing	116	12.2
Physics	101	10.6
Mechanics	88	9.3
English	74	7.8
Laboratory courses	39	4.1
Engineering subjects	30	3.2
Shop courses	20	2.1
Others	4	0.4
		100.0

24. OPINIONS OF NON-GRADUATES AS TO PRINCIPAL DEFECTS IN ENGINEERING COURSES.

	Number.	Per Cent.
Too little attention to the problems of the individual student	218	21.4
Failure to correlate study with practice	135	13.3
Examinations given too much weight	109	10.7
Poor teaching	105	10.3
Too much "theory"	92	8.9
Too much history, languages, etc.	87	8.6
Too little history, languages, etc.	73	7.2
Too much work required	64	6.3
Too many courses given at the same time	49	4.8
Too much shop, drafting, report writing, etc.	46	4.5
Others	41	4.0
		100.0

ERRATA.

Page 217, after fourth line of first paragraph insert the following line:

tion to prepare conclusions and recommendations looking to

The illustrations for Fig. 1 on page 219 and Fig. 2 on page 222 should be transposed, allowing legends to remain as they are.

ENGINEERING TEACHING PERSONNEL *

Purposes.—The purposes of this study were to obtain through statistical means as accurate a conception as possible of certain aspects of the status of engineering teachers in the United States and Canada and upon the basis of that informa- the improvement of teaching staffs.

Sources of Information.—Data relating to engineering teachers were obtained through the cooperation of committees of the faculties, through individual teachers, and through the deans or other administrative officers of engineering colleges throughout the two countries. The numbers of institutions and of individuals supplying information are as follows:

Economic status of engineering teachers—2,279 teachers in 75 institutions, 80 per cent of those canvassed supplied information.

Policies pursued by the colleges in connection with recruitment and development of teaching staffs—116 institutions.

Sources from which teachers are drawn and positions which teachers fill when they leave the colleges—71 institutions.

Degrees held by teachers of engineering students—143 institutions and 8,598 teachers.

Teaching loads of engineering teachers—76 institutions and 2,289 teachers.

The institutions included represent all types which offer engineering courses leading to degrees and all parts of the United States and Canada.

Auspices.—The project was carried out under the sponsorship of the Committee on Teaching Personnel:

Charles H. Warren, *Chairman*, Yale University,
W. H. Kenerson, *Secretary*, Brown University,
J. H. Cissel, University of Michigan,
H. E. T. Haultain, University of Toronto,
Charles S. Howe, Case School of Applied Science,

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M. S. Ketchum, University of Illinois,
P. F. Walker, University of Kansas.

The committee has presented three reports during the course of its studies. The first two dealt with the accumulated data and presented comments thereon. The other contained the committee's conclusions and recommendations. These reports with such editorial changes as were needed for the purpose, together with the accompanying tables of data have been consolidated and constitute the material which follows. It is divided into three parts. Part I, which presents the committee's discussion of the data, corresponds with the first two reports. Part II presents the committee's conclusions and recommendations. Part III comprises tabular summaries of data.

PART I. DATA RELATING TO ENGINEERING TEACHING PERSONNEL

(The tables of data referred to may be found on pages 249–261 inc.)

A. Recruitment and Losses

Sources from Which Engineering Teachers are Obtained.—Data relating to the recruitment of engineering teaching staffs are summarized in Table 1 and Fig. 1. They show that a majority (67.1 per cent) of all positions are filled through promotion from graduating classes and from the teaching ranks, so that the body of our staffs is built up from this source. There is a substantial interchange between schools, ranging from 11.4 per cent in the case of assistants to 37.5 per cent for deans, the average being about one-fifth for all grades. There is also a notable proportion of teachers derived from engineering practice, ranging from about one-fifth for the professorial ranks to about one-third for instructors.

The percentages of instructors and assistants secured from other institutions deserve comment. This number is due in part doubtless to a policy of securing men with varied training and experience, but it is also probably connected with a

tendency on the part of the young men themselves to gain experience, or to pursue further study at an institution other than the one from which they graduated. Whatever the cause, it is a healthy situation, pointing as it does to a considerable circulation of young men among the schools.

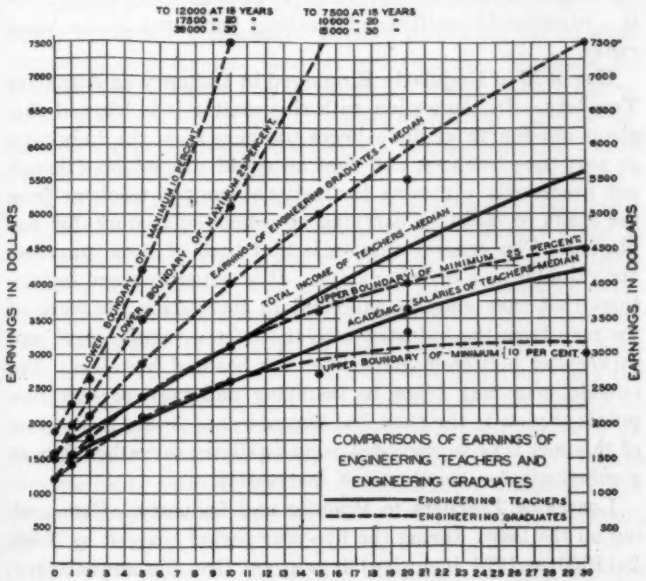

TO 12000 AT 18 YEARS
17500 = 25 "
29000 = 30 "
TO 7500 AT 18 YEARS
10400 = 20 "
15000 = 30 "
LOWER BOUNDARY OF MAXIMUM 10 PERCENT
LOWER BOUNDARY OF MAXIMUM 25 PERCENT
EARNINGS OF ENGINEERING GRADUATES — MEDIAN
TOTAL INCOME OF TEACHERS—MEDIAN
UPPER BOUNDARY OF MINIMUM 25 PERCENT
ACADEMIC SALARIES OF TEACHERS—MEDIAN
UPPER BOUNDARY OF MINIMUM 10 PER CENT
COMPARISONS OF EARNINGS OF ENGINEERING TEACHERS AND ENGINEERING GRADUATES
ENGINEERING TEACHERS
ENGINEERING GRADUATES
EARNINGS IN DOLLARS
EARNINGS IN DOLLARS

FIG. 1. Sources from which engineering teachers are obtained and annual losses of teachers.

The return of young men from industry is also probably on the whole a satisfactory state of affairs. Many of them probably desire to get a more thorough grasp on theory and plan to do graduate study along with their teaching. They should come back from industrial work with a broadened viewpoint and a clear idea as to what is important in education. We should not overlook the fact, however, that some of these young men come back because they find industrial work not

to their taste, or the pace faster than they can maintain. An uncertain proportion of them are probably of doubtful value.

It is significant to note from Table 1 that the number of new men of the rank of instructor and lower who have been added to the staffs in a period of five years exceeds the number of men holding such positions at present. Evidently there is a considerable shifting of teaching personnel in the lower ranks.

Use of Men Regularly Employed in Industry as Auxiliary Teachers.—In connection with this matter it is learned that about one-fourth of the colleges use men from the industries as part-time teachers, and that an equal proportion (though not necessarily the same institutions) supply teachers from the staffs to assist in carrying on educational work for employees. The general opinion is that both of these practices are valuable to a certain extent. It is noted by some institutions that care must be exercised in correlating the work of the man from the industry with that of the regular staff, and in keeping him from going over the head of his class. The outside man may often be inspiring and may present new points of view to the class, but the inference is that instruction of this sort is to be regarded as an auxiliary to, rather than as a substitute for, regular staff instruction.

Losses of Teachers to Practice and Industry.—Commenting on the losses during the five-year period covered by Table 2 (1920 to 1924 inclusive) it appears that the annual turnover for all grades of teachers and for all changes of positions is about ten per cent. The actual annual loss of teachers by the institutions is about seven per cent. In the grades of instructor and assistant the percentage of losses is much larger than in the professorial grades, 11.5 per cent as compared with 3.35 per cent. The total percentages of teachers who change their positions per year to go to other institutions or to leave teaching are as follows: to take another teaching position, 3.37 per cent; to enter practice, 4.46 per cent; to enter business, 1.09 per cent; to enter other activities, 1.13 per cent, a total of 10.1 per cent, as above mentioned. The total loss

of teachers above the rank of instructor per year, is about three and one-third per cent of the total number of teachers of those ranks.

B. Economic Status of Engineering Teachers

Salaries and Supplementary Earnings.—The results of this study constitute a successful attempt to picture the financial status of a particular class of individuals. The data are summarized in Tables 3 to 5 inclusive. About 2,850 questionnaire cards were distributed to members of the staffs of seventy-five representative institutions throughout the United States and Canada. Eighty per cent of those canvassed, or a total of 2,279 individuals submitted responses in a form which could be tabulated. It is believed that the figures given in the summary tables are quite reliable and furnish an entirely trustworthy cross-section of the present (1925) financial situation of the teachers of engineering. It may be that a few very large supplementary incomes have not been reported, but since results are reported as medians it is not likely that these few cases would materially affect the results. In this connection it may be noted that a considerable number of incomes in excess of $10,000 per year are included. The tables give figures for academic salaries and "supplementary" incomes. The latter include income from all sources except inheritances and gifts.

The figures for maximum and minimum salaries call for little comment. It is possible that the exceptionally low salaries of some individuals of long periods of service may represent shop instructors, or possibly even teachers on part-time, though the cooperating institutions were requested not to circulate questionnaire cards to the latter.

Supplementary Incomes.—Of the 2,279 individuals reporting, 1,785 state that they have supplementary incomes, the percentages for the various ages ranging from 58.5 to 100, with an average for the entire group of 78.5 There is a gradual increase in this percentage, with minor fluctuations. The supplementary incomes show a gradual increase through-

out the period, the median figure for those reporting supplementary incomes advancing to $2,000 at its highest point. There is a noticeable but unexplained sudden increase in the supplementary incomes at the twentieth year after graduation. Preceding this year the incomes from supplementary sources range from $600 to $880 per year. At the twentieth year there is a sudden increase to $1,200 per year. From this point on the supplementary incomes in four figures continue. The supplementary incomes rather rarely reach one-third of the median or most frequent salaries.

Earnings of Teachers and Graduates Compared.—The data of this and other studies afford a basis of comparison with the earnings of engineering graduates in practice. Table 6 and Fig. 2 show the ratio of salaries of teachers of engineering to those of graduates. At the start the teachers salary and total earned income exceed the earnings of graduates by a small amount. At the end of one year their total in-

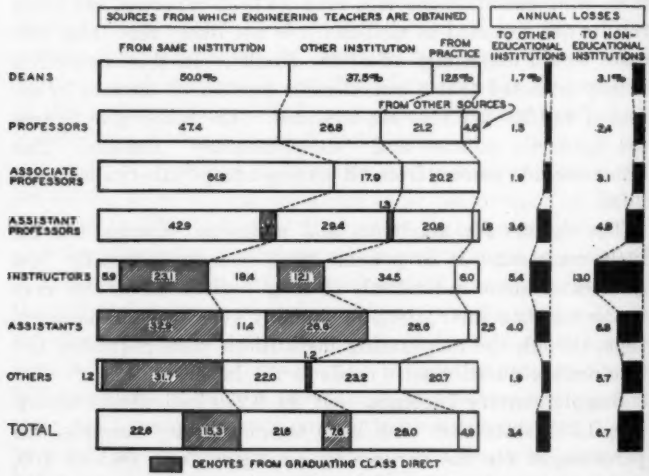


FIG. 2. Comparisons of earnings of engineering teachers and engineering graduates.
Based upon information supplied by 5,023 graduates and 2,279 teachers.

comes are practically equal. After one year the teachers earn steadily less than graduates in practice, until at the thirtieth year after graduation the median total earnings of teachers are but 74 per cent of those of graduates in practice. When academic salaries—either median or most frequent—are made the basis of comparison, the status of the teacher as to earnings is, of course, still less favorable. The young teacher beginning his career must look forward in general to a smaller income than if he went into practice—assuming that his earning capacity in industry is proportionately as great as it is in teaching.

Salaries of Various Teaching Ranks.—Table 5 presents a summary of salaries arranged according to teaching rank. This table includes sixty-nine of the seventy-five institutions of Table 3. The institutions have been carefully chosen and probably give a reliable cross-section of salary levels throughout the United States and Canada. The small median and most frequent salaries of deans and professors are striking. If we compare these salaries with those arranged by years since graduation, using the most frequent salaries as an index, we may conclude that teachers normally reach the rank of assistant professor in about eight years, the rank of associate professor in about fifteen to twenty years, and that of professor in from twenty to twenty-five years.

C. Demands on Teachers' Time

Teaching Loads.—Tables 7 to 10 inclusive and Figs. 3 to 6 inclusive give data regarding the teaching loads of members of engineering faculties. The unit employed is the college "hour" of required presence in class room or laboratory. No effort has been made to reduce the several types of instructional work to the basis of "credit hours" or similar units, for the reason that there is no accepted standard in use for the purpose. The only universally known and understood unit appears to be the college "hour", a period which is usually of 50 to 55 minutes' duration. It is probably not entirely satisfactory to rate all varieties of instructional work equally,

but it would probably be even more unsatisfactory to attempt to use a method of evaluation which had not been accepted in a majority of the institutions.

The general average teaching load carried by teachers of all ranks from which departures for the various grades are surprisingly small, is 17.6 hours per week. Excluding the deans the average load is 18.0 hours per week. It is interesting to note that if the average length of the class room hour be taken at 55 minutes, the teaching load for engineering teachers (excluding deans) is 990 minutes per week, which is

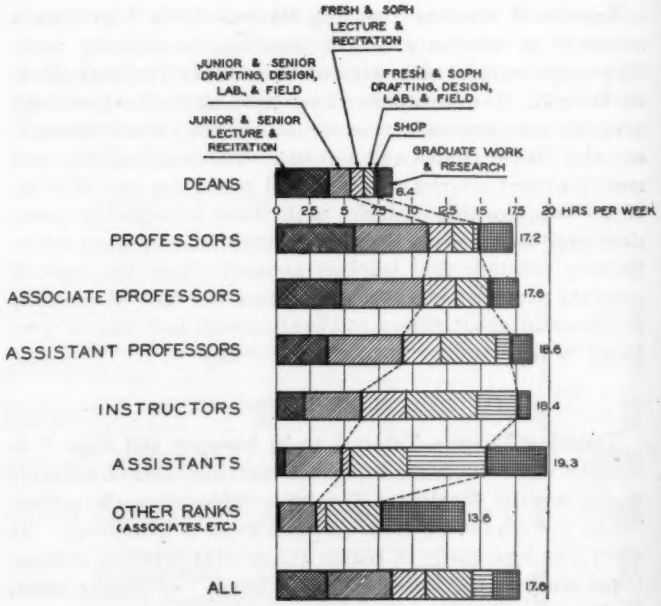


FIG. 3. Teaching loads of engineering teachers.

very close to the average for high school teachers carrying a full schedule of 1,000 minutes per week.

Demands on the Teacher's Time.—Everyone familiar with

the situation knows that the number of hours of actual attendance in class room and laboratory is by no means an accurate indication of the demands upon the teacher's time. To this must be added the time required for preparation for classes and for the planning of problems, projects and experiments; the time required for the maintenance and operation of laboratories, and for correction of problems, reports and examinations. There must also be added the time, often considerable, devoted to conferences and committee assignments. It is very difficult to estimate the time required for these supplementary duties but it is probably quite within the limits of accuracy to state that the teacher who carries on his work conscientiously and assists to a reasonable degree in the committee activities of an engineering college devotes as much time to duties outside of the class room as he does to actual class room attendance. It must also be remembered that the hours of class room attendance during the week are not scheduled as a single block but that they come at irregular intervals both in the morning and afternoon, breaking up the day unprofitably as far as really free time is concerned.

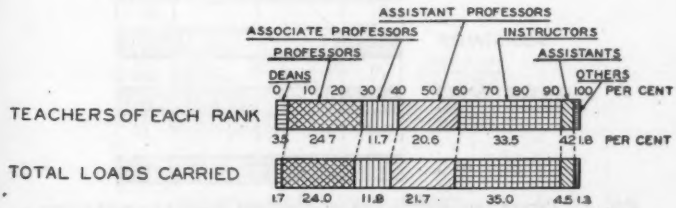


FIG. 4. Relationship between percentage of teachers of each rank and total loads carried.

Proportional Loads of the Several Ranks.—The data bring out one fact very clearly, namely, that each rank carries a teaching load which is in almost exact proportion to the number of teachers in that rank. (See Table 7 and Fig. 4.) The division of teaching staffs as to rank seems on the whole to be quite satisfactory. Deans and professors constitute 28.2

per cent of the total, associate and assistant professors 32.3 per cent and instructors 33.5 per cent. The percentage of full-time men of the rank of "assistant" is small—4.2 per cent, probably not greater than the amount of work which should properly be delegated to these younger men. The small proportion of teachers of this rank should be borne in mind in studying the division of teaching loads.

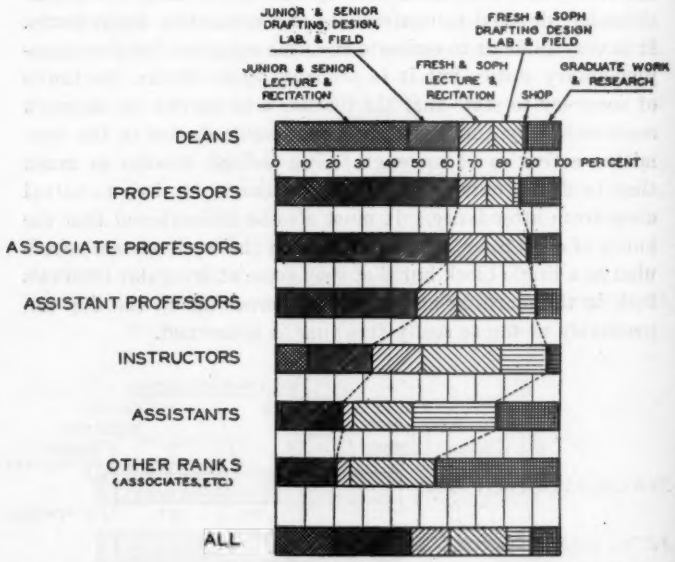


FIG. 5. Percentage distribution of teaching loads of engineering teachers.

Participation in Various Kinds of Instruction.—It is rather striking that while there is, as would be expected, a considerable increase in the load of laboratory, drafting room and shop work as the lower teaching grades are approached, and that a relatively larger proportion of the time of teachers of junior rank is devoted to freshmen and sophomores, there is on the whole a rather general participation of

all ranks in all kinds of instructional work. (See Tables 8 and 9, Figs. 3 and 5.) In this connection special attention may be called to the work of teachers of the rank of assistant. It will be noted that there are but ninety-five such teachers on full-time duty in the seventy-six institutions reporting and that while they devote an average of 19.3 hours per week to definitely assigned duties, 15.9 hours of this total are devoted to laboratory, field, shop and research work, but 0.9 hours per week to actual class room teaching and 2.5 hours per week to drafting and design courses.

Instruction of Graduate Students.—The tables show that the time devoted to the instruction of graduate students is small throughout the country as a whole, and point to the fact that our engineering education is predominately undergraduate in character, in spite of the fact that about one-half of the institutions offer graduate courses in engineering. It is of course true that many of the larger and stronger institutions give a considerable amount of graduate instruction. This must mean that many engineering schools are giving very little or none at all in order to bring the average down to the small figure shown in the tables.

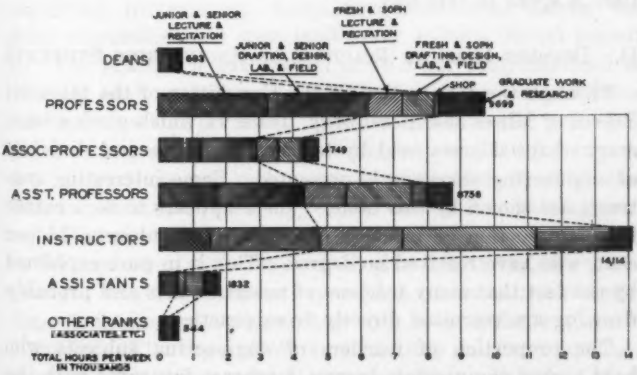


FIG. 6. Division of teaching duties among teachers of various ranks. Length of bars is proportional to total teaching load of corresponding rank.

Time Devoted to Research.—Turning to the figures showing the time devoted by teachers to research work, it should be noted that time devoted to research in connection with outside consulting practice is not included. The results indicate that in our engineering schools as a whole the engineering teacher is not active in research, 1.3 hours per week being the general average for all ranks (Table 8). The *percentage* of the teacher's time devoted to research has less significance, than the *actual* time spent. If this be connected with the fact, also brought out by this investigation, that the amount of outside professional work is not large on the whole, it must be concluded that engineering teachers as a group are mainly occupied with their teaching duties. This is the inevitable outcome of the heavy load of class room duties which the teachers carry.

Again as in the case of graduate study attention should be called to the well-known fact that in the larger and stronger schools a very considerable amount of time is devoted by many members of the teaching staff to research work, so that in order to produce the very low averages for time actually spent in research, there must be many institutions where very little time is spent in this way.

D. Degrees Held by Teachers of Engineering Students

Through the cooperation of the Committee of the Missouri School of Mines and Metallurgy, Table 11 which gives a summary of the degrees held by teachers in the several divisions of engineering curricula is presented. Some interesting contrasts are shown by this table. There appears to be a rather large proportion of teachers of engineering subjects, 14 per cent, who have received no degree. This is in part explained by the fact that many teachers of mechanic arts and probably drawing are recruited directly from practice.

The proportion of teachers of engineering subjects who hold higher engineering degrees compares favorably with the proportion of those teaching chemistry, mathematics, etc., who hold the doctor's degree. Those who hold higher engineering

degrees have usually spent a considerable amount of time in engineering practice in fulfilment of the requirements for such degrees. This is as it should be, for each of the two higher degrees represents the completion of an appropriate preparation for a distinct field of teaching.

There is a decidedly larger proportion of those holding bachelor's degrees among engineering teachers than among those in the other divisions. It would be better if there were a larger proportion of men who have extended their study period beyond undergraduate years. This would furnish us with teachers better grounded in theory and practice, provided the graduate study were properly completed or supplemented by engineering practice as a part of the requirement. There is little doubt but that the situation is rapidly improving.

E. Supplementary Professional Practice of Engineering Teachers

Professional Practice during the Academic Year.—The data indicate that teachers are permitted to engage in practice during term time in 96 per cent of the 116 institutions supplying information. Only five institutions among the state universities and state land grant colleges do not permit it. The practice is encouraged in 68.5 per cent, tolerated in 27.0 per cent, and discouraged in only 2.7 per cent of those institutions which permit it. Two institutions (1.8 per cent) did not answer this question. So few institutions impose any restrictions on such work, except that it shall not interfere with the teacher's regular duties, that this appears to be the prevailing practice. The matter is in general left to the good sense of the individual, although in the case of the younger men there is some supervision by those in authority, some fourteen institutions exercising some definite plan of oversight. The type of work which may be done does not seem to have come under close supervision. Fifteen out of the 111 institutions which permit outside work during term time definitely specify it must be such as to advance professional standing.

The fact that there are so few restrictions; that so many encourage outside work by teachers during term time; that there are definite arrangements in many institutions for the purpose of assisting the younger teachers to obtain such work; and that in general the individual members of the staffs are trusted to use their own discretion as to how much and what sort of work they shall do, seems to indicate that the practice is looked upon as a healthy one, and that it has not been abused. The evidence furnished by the data on supplementary incomes of teachers points in the same direction. The incomes from this source are moderate on the average and unless the rate of pay is absurdly small, the total bulk of outside work can hardly be regarded as sufficient to present any really serious problem—this remark applying, of course, to the situation as a whole.

Professional Practice in Industrial and Non-Industrial Centers.—It may be further remarked that the proportion of teachers located in colleges in or near large industrial centers who engage in outside professional work is not materially greater than that of the teachers in more remote institutions. The volume of work done, as judged from amounts earned, however, appears to be considerably greater. The following tabulation gives a rough indication of this situation. The

COMPARISON OF INCOMES OF TEACHERS IN INDUSTRIAL AND NON-INDUSTRIAL CENTERS.

	Years After Graduation.	Number of Individuals.	Number Reporting Supplementary Incomes.	Per Cent Reporting Supplementary Incomes.	Median Total Income.	Median Supplementary Income.
Industrial.....	1–10	508	361	71.1	2530	634
Non-Industrial..	1–10	443	281	63.5	2105	408
Industrial.....	11–20	392	354	90.5	4270	995
Non-Industrial..	11–20	340	286	84.2	3780	624
Industrial.....	21–30	218	194	89.0	5440	1460
Non-Industrial..	21–30	163	138	84.7	4620	1052
Industrial.....	31–40	102	95	93.0	6740	2080
Non-Industrial..	31–40	60	50	83.3	4610	1180

figures for income were obtained by averaging medians for ten-year periods.

Use of Laboratories for Outside Work.—This subject is related closely to the previous one. Only three of the institutions which permit outside practice by members of the teaching staff do not permit the use of college laboratories in connection with such work. In 44 per cent of the institutions which do permit the laboratories to be used, materials and certain other costs are paid for by those who use the laboratories. In 40 per cent of the institutions a fee is charged in addition for the use of the laboratory. There are also certain other special regulations. It is to be noted that in only one institution, as far as known, is any definite attempt made in connection with use of laboratories to fix a charge for overhead computed as a certain percentage of labor costs. Why should the institution not be reimbursed for overhead as well as for materials and labor? The former is usually unknown but probably cannot be less than 50 per cent of labor cost. Probably the volume of work has not been great enough to be a serious item and has simply been allowed to go into the general expense account of the institution.

Use of Name of Institution in Connection with Outside Work.—Approximately four-fifths of the colleges look upon the individual doing the work as solely responsible for results, and institutional responsibility is disclaimed or expressly denied. Ten per cent state that the professor may state his identity with the institution, though this probably does not imply any responsibility of the institution for results. Institutions having experiment stations send out official reports confined to data but give no opinion or guarantee as to their value.

F. Opportunities for Development

Sabbatical Leave.—Sixty-five per cent of the institutions have no policies as to sabbatical leaves for teachers of engineering. Thirty-two per cent of the institutions have policies of varying types. The frequency of permitted leaves varies from one-half year in three to one year in eight; the term

sabbatical evidently not being confined to its strictly derivative sense. Salary during leave is usually adjusted on the basis of half year with full pay or full year with half pay.

It is rather significant to note that in the past five years only seventy-seven leaves of absence of all kinds have been taken by teachers of engineering in 116 institutions having a total faculty of perhaps three thousand members. The rate is about fifteen individual leaves per year or about 0.5 per cent of the total number of teachers. It would be interesting to know how these figures compare with those for college teachers in other lines. It seems possible that teachers of engineering avail themselves of sabbatical leave to a lesser extent than other teachers. If there were more demand for such leaves it is probable that the practice would be more general, and it is probably a fact that engineering teachers supply the want of leaves of absence through the practical engineering work which they carry on during the college year and in vacations.

Assistance to Younger Teachers in Broadening Their Experience.—Of the 116 institutions reporting, 79 per cent give such assistance while 18 per cent do not. Apparently there is a strong tendency to assist younger teachers to secure vacation employment. One institution, the New Mexico College of Agriculture and Mechanic Arts, not only makes an effort to place its staff in vacation work, but actually provides financial assistance to members of its faculty for pursuit of courses of study, etc. A few others make similar arrangements through grants from endowment funds. This is excellent for the younger men.

Instruction in the Art of Teaching.—Data were gathered on this subject because there is constant criticism from certain sources that the art of teaching is neglected in engineering colleges and that men are hired to teach rather because of their knowledge of the subject than their ability to impart it to others. The returns indicate that 85 per cent of the schools give no systematic instruction in the art; 5 per cent answer in the affirmative for all departments; 5 per cent state that such

instruction is given in some departments; and about 5 per cent did not reply to the question. In connection with this matter it is to be noted that in 21 per cent of the institutions it is customary for the older teachers to visit the classrooms of younger teachers, and that in 33 per cent it is customary for the younger teachers to observe the methods of older teachers. About three-fourths of the faculties seem to feel that such instruction is or could be made of substantial value; about one-fifth feel otherwise. There seems to be a rather mild feeling that some sort of instruction might be made of value, but there is much doubt as to whether or not anything worth while can be done, or, if it could be done, who should do it and how.

PART II. CONCLUSIONS AND RECOMMENDATIONS OF THE COMMITTEE

The General Situation.—Beyond the basis of fact now in our possession there is still, as we all recognize, much that is more or less intangible and impossible to set down in cold figures which, nevertheless, must be taken into account in the solution of our educational problems. The basis of fact secured will, however, assist us materially in analyzing and evaluating these less tangible features of our educational environment.

The general situation as regards teaching personnel, in so far as it is disclosed by the data collected, is on the whole an encouraging one. The teachers of engineering subjects are certainly doing their work energetically and conscientiously; they are obviously thoroughly alive to the fact that they have important problems before them and are earnestly and actively seeking their solution. This in itself is an evidence of vitality which indicates that the time is ripe for an advance to a higher level of achievement.

A. Selection of Teachers

Encouraging Aspects.—As pointed out previously, the general situation in this connection is quite satisfactory *insofar*

as can be judged by the statistical evidence presented. There appears to be a normal and desirable fluidity in the loss and gain of teachers, particularly in the lower grades. The total turnover in all ranks is about ten per cent, which is not unduly large. With an average interchange of teachers of about one-fifth between schools, and with from one-fifth in the professorial ranks to one-third in the ranks of instructor derived from engineering practice, it appears that the engineering schools are providing very satisfactorily for a desirable interchange or circulation of teachers, particularly the younger men, between schools and for a constant addition to the teaching ranks of men who are bringing into teaching the viewpoint of the engineer in practice. This situation seems to afford a guarantee against the danger of too much standardization or the development of a too strictly academic atmosphere.

The losses to practice, industry, and business are relatively small particularly in the higher ranks and there is nothing in the data to support the often heard complaint that industry to a dangerous extent is draining the schools of their best men. It must be remembered, however, that the data cannot show to what extent those whom we do lose are the sort with which we can least afford to part.

Is the Quality Satisfactory?—Are we drawing our younger teachers from among the highest level of those graduating year after year from our engineering schools as measured not alone by their scholastic records but by their character and all round promise? Many of those in administrative positions feel that in general we are not doing so but that industry and practice are getting and holding these men, and that it is in just this way that industry is taking away the best talent from the teaching profession. To avoid a danger of this sort and to obtain the best possible material it will be necessary to render teaching positions so attractive that they will be eagerly competed for. If we can by any means whatsoever render the professorial position generally recognized as one of real prestige, to be gained and held only through severe competition and hard work, our problem is solved. Larger

and adequate salaries, larger opportunities to take part in engineering practice or research work, or both, a more careful scrutiny of candidates on the basis of all-round qualifications, will doubtless be the principal means toward the end desired.

Teachers of Related Non-Engineering Subjects.—Thus far our investigations and comments about teaching personnel have been confined to teachers of engineering subjects or at least to teachers who report to the dean or faculty of engineering. In many universities instruction in mathematics and physics is not under the jurisdiction of the engineering division or school, but under a university department over which the engineering faculty has little or no direct control, and indeed has often very little influence either as to the engaging of teachers or as to the subject matter of the instruction. It is perfectly well known that there is too often a lack of proper coordination between one or both of these subjects and the engineering work. There are often sharp differences of opinion and lack of understanding between the teachers of these subjects and those who teach the technical courses which are themselves so largely compounded of what is essentially physics and mathematics. This is not the place to enlarge upon this matter, but it is a vitally important problem; indeed it seems to be one of the most important problems before the engineering schools today.

B. Teaching Loads

Present Loads Often Excessive.—The teaching load for all ranks is uniformly heavy as compared with that borne in general by academic teachers. The average number of teaching hours (actual contact hours of fifty-five minutes each) is very close to eighteen and there is no great departure from this average for any rank (excluding deans). The general opinion seems to be that eighteen hours of actual teaching is too heavy a load since it certainly entails at least an equal amount of auxiliary work, preparation, marking of papers, etc., and that therefore the total amount of time and effort expended on the teaching duties alone leaves too small a mar-

gin of time for developing professional contacts, research, study, recreation, exercise, and in short general self-development. The small amount of outside professional work and the very meager number of hours which on the average are devoted to research work support this contention. Fifteen hours per week seems to be a more desirable general maximum teaching load. Fifteen hours per week for the assistants and young instructors would be considered by some as too light a load. The thought has indeed been expressed that with only fifteen hours of work the assistant or instructor would not have enough work to occupy his time, and would perhaps fall into lazy habits. This result would very likely occur if the young instructor or assistant had no further requirements outside of his required teaching duties. It would seem, however, to be a better practice to require not more than fifteen actual contact hours and then insist that the younger men devote a substantial amount of time to advanced study, research, or practical investigations. It is during this period that scholarly habits of study and research are most easily acquired and if not acquired then, there is grave danger that they never will be. The young instructor is in danger of developing into a mere routine teacher.

Taking all the available facts into consideration it must be concluded that in the engineering schools of the United States and Canada taken as a whole, by far the greater part of the time and energy of the teachers is devoted to the work of undergraduate teaching. The time seems to be ripe for lessening the burden on the individual teacher of the formal undergraduate teaching and for an increase in the time devoted to more advanced instruction, to engineering practice, research, and to whatever tends to enrich and develop the teacher as an engineer and a man.

Balance of Loads Among Teaching Ranks.—It is clear that teachers of all ranks bear their proportional and full share of the teaching load, and that there is a much more satisfactory contact between teachers of all ranks and students of all grades than most of us supposed would be found to be the

case. Conditions have probably made it inevitable that a larger proportion of the teaching of the more elementary subjects of the earlier years has fallen on the younger and less experienced though not necessarily less effective teachers. As previously remarked we should guard against any increase in the proportion of the latter class entrusted with the important task of teaching the elementary subjects to the younger students.

Textbook Writing.—In discussing the activities of our teachers the matter of textbook writing has not been touched upon heretofore. The ever-increasing number of textbooks published annually on engineering subjects is sufficient evidence that a great deal of time is used up in this way. One can scarcely avoid thinking of this when contemplating the data on time devoted to research and engineering practice. The value of this work when done by teachers of ripe experience and recognized attainments in their chosen field cannot be questioned. Neither can it be doubted that the younger and less experienced teacher may, through the writing of texts extend and consolidate his knowledge of his subject and improve himself in the exposition of it. We may however fairly question whether the time thus spent might not if spent in productive investigations, research, or in professional work result in a more real and enduring benefit to engineering science and to the teacher himself. It is to be feared that textbook writing is often undertaken by those who find it easier to work over pre-existing material than to produce new material through research. We know many young professors undertake it frankly in the hope of adding to a somewhat meager income and gaining recognition which will lead to a promotion.

C. Compensation and Tenure

Primary Importance of Compensation.—Turning now to the question of what can be done to secure and keep in the teaching ranks men possessed of the characteristics and ability deemed essential to the further program of engineering education, we come at once to the question of financial re-

muneration. All will probably agree that this plays a most important part in securing and maintaining satisfactory teaching personnel. Whatever may be said regarding the other compensations which reward the teacher's career, in the last analysis the financial return will be found to be the most important single consideration. The proposition is difficult to state without offense to some of our cherished ideals and without laying ourselves open to the charge of a materialistic bias.

Whatever the reasons may be that lead a young man to enter the teaching profession, one thing is certain: He will not stay in it, if he is a normal young man with ability and courage unless he can be reasonably certain of making a satisfactory living as judged by the commonly accepted standards of the social order in which he finds himself. Moreover every graduating student knows about the small salaries paid to teachers and this knowledge added to certain unfavorable impressions which he may have secured first-hand during his career as a student leads him very often to avoid teaching.

The data show clearly (Fig. 2, page 222) that engineering teachers' salaries even when supplemented by outside earnings are decidedly less than are the incomes of the most nearly comparable class, engineering graduates in practice. Teachers in some specially favored institutions are better off than this, but even here, except for a very few specially favored individuals, the total income does not exceed the median income of the practicing engineer, and does not approach very closely even the lower limit of the income of the maximum twenty-five per cent of engineers in practice. To the young graduate looking forward to a career, the engineering teacher's prospects look at best like a decidedly second rate chance so far as income is concerned.

How the Present Scale Limits Recruitment.—If salaries and total earned incomes of engineering teachers remain on the present basis it will doubtless be true in the future as it has been in the past that the teaching profession will continue to attract able men who are willing to face the smaller

financial returns because of the opportunities for study and research, and for the relative freedom and permanency to be found in academic positions. Men in practice who have perhaps laid by a competence and have a taste for scholarly pursuits and an interest in education, and who perhaps have had all the experience in practical affairs they want, will from time to time join the ranks of the teachers. Possibly a permanent and not too strenuous berth with pleasant social accompaniments appeals to them. We shall, however, still continue to get too large a proportion of men who do not represent the highest type of our graduates, and who seem to gravitate toward teaching from negative rather than positive reasons. All administrative officers know how adhesive this type is. We should not lay too great weight on the fact as shown by the data that industry does not appear to be drawing away any considerable proportion of our teachers. Perhaps they take all they believe are of any particular value to them, and some of these may be the very men we need most to keep.

If we are to raise the general standard of our teaching personnel above the present level (and this appears to be the essential and most obvious means of improving engineering education), we must as remarked above, offer salaries which are at least the equivalent of the financial return which the engineering graduate may reasonably expect to receive in practice. To such a salary the ambitious, energetic, and capable teacher may add a fairly substantial amount by outside practice, but he will even then find himself, so far as income is concerned, in the ranks of the lower part of the upper twenty-five per cent of engineers. We cannot expect a young man of spirit and ability to enter or remain in the teaching ranks if he must occupy an inferior position as judged by the standards of the social order in which he lives in respect to the ordinary relations of life. We must raise our salary scale if we are to have our teaching positions desired and competed for by the kind of men we must have.

Proposed Salary Scale.—In proposing an increased salary scale it is clear that it is impossible to devise one which will

be suitable for all schools, and also that to propose such an increase is very easy but to get it is quite a different matter. The scale proposed below should be regarded as a goal toward which we may at least work. It is a scale which will have to be met before long by those schools which aim to provide the highest grade of engineering training such as is being demanded by the public we are striving to serve. Certainly a large portion of the advance will have to be met by larger endowments or grants. Perhaps by means of a more rigorous selection of students worthy of advanced training, the numbers to be taught, and consequently the number of relatively higher paid teachers could be reduced.

The scale herewith proposed is based approximately on the values disclosed by the curve for median incomes and by figures for the incomes of the maximum 25 per cent of graduates in engineering practice. (See Fig. 7.) It is shown in Figure 7 by the step-formed curve. This, as can be seen, is situated rather uniformly above the curve of median incomes for engineers in practice and approaches, or even touches, the lower boundary curve for the maximum 25 per cent of engineers in practice.

Position.	Salary.	Approximate Normal Number of Years After Receiving First Degree.	
Instructor	$ 1,500	1	
	1,800	2	
	2,100	3	Yearly
	2,500	4	Advance
	3,000	5	
	3,500	6	
Assistant Professor	4,000	8	
	4,500	10	Appointments and Advancements at two year intervals
	5,000	12	
	5,500	14	
Associate Professor	6,000	17	Appointments and Advancements at three year intervals
	6,500	20	
Professor	7,500	21 et seq.	
Increase to maximum of	12,000		

This salary scale starts at $1,500, for the reason that this figure represents about as much as an inexperienced man just out of college ought to expect. This is in fact about the salary that a graduate would receive if he took a position with an

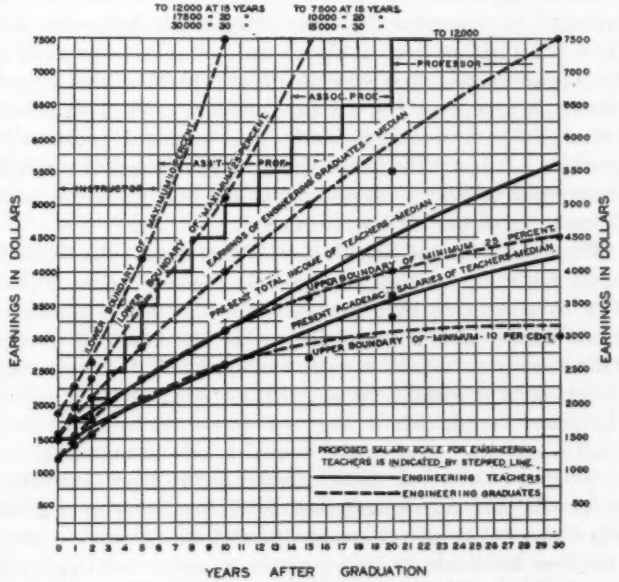

TO 12000 AT 15 YEARS
17800 = 30 "
30000 = 30 "
TO 7500 AT 15 YEARS
10000 = 30 "
15000 = 30 "
TO 12000
PROFESSOR
ASSOC. PROF.
ASST. PROF.
INSTRUCTOR
EARNINGS IN DOLLARS
EARNINGS OF ENGINEERING GRADUATES - MEDIAN
PRESENT TOTAL INCOME OF TEACHERS - MEDIAN
PRESENT ACADEMIC SALARIES OF TEACHERS-MEDIAN
UPPER BOUNDARY OF MINIMUM 25 PER CENT
UPPER BOUNDARY OF MINIMUM 10 PER CENT
PROPOSED SALARY SCALE FOR ENGINEERING TEACHERS IS INDICATED BY STEPPED LINE
ENGINEERING TEACHERS
ENGINEERING GRADUATES
YEARS AFTER GRADUATION

FIG. 7. Proposed salary scale for engineering teachers.

engineering concern or with some industrial company. An exceptionally good man or one having a year of practical experience might be started at $1,800. Perhaps the latter figure may also be taken to be a fair beginning salary for an engineering teacher who has taken postgraduate work. Exceptional cases will naturally occur and will have to be treated as circumstances dictate. On the whole it is felt that the engineering colleges should adhere rather closely to the general rate of remuneration for beginners that obtains in outside engineering practice. The data indicate that a somewhat

higher rate of pay for first appointments prevails in a considerable number of institutions at the present time. Two thousand dollars is not uncommon and apparently even more is sometimes paid. These higher initial salaries are doubtless offered in an attempt to secure a better grade of man and are intended to overcome the competition with industries and those institutions where a higher scale of salaries prevails in the upper ranks. The wisdom of over-bidding the general market is very doubtful. A far sounder policy is to adhere rather closely to the initial salaries paid in outside engineering practice. It is not the initial salary that will secure and hold the type of man we want but rather the prestige and general desirability of the highest positions.

Proposed Normal Schedule of Promotion.—Provision is made for a steady and rapid yearly increase up to $3,500. The data indicate that promotion to the first professorial grade comes, if at all, usually within the first eight years. This seems a reasonable apprenticeship, but if for any reason it appeared desirable to shorten or lengthen this period the salary appropriate to the position should be paid. During the assistant professorial period a substantial salary beginning at $4,000 with $500 increases at two year intervals is proposed. It is during this time of life that the teacher generally feels most keenly the pinch of insufficient means. During this time he should be in a position to make social and professional contacts and have time for research work and for some recreation and exercise. To cramp him here is to prejudice his future prospects of growth. The same applies to the associate grade.

It is assumed that men will not be passed into the associate grade unless they have pretty fully demonstrated their ability and are in line for a professorship. On the other hand it might be a grade appropriate for the occasional man whose value as a teacher, or as a teacher and officer, is well recognized but whose all-round attainments are not such as to single him out for the highest rank. If the position is well paid it will be rated as a dignified and worthy office, a step below the highest rank attainable.

For the full professor a minimum salary approximating the present day maximum of our engineering colleges is proposed. Provision is made for advance on the basis of length of service, or achievements, or both. The maximum of $12,000 should be paid only for unusual achievement, and in recognition of the highest merit. We believe that this is as it should be, for in the professorial grade we ought to be dealing only with the man whose talents would win him a handsome reward in any calling. As remarked above it is the attractive character of the higher positions which in the long run will attract and hold men of the highest character and ability.

Tenure.—The question of permanent tenure has been made the subject of study by the American Association of University Professors; this investigation has not heretofore touched upon it. Permanent tenure is generally looked upon at present as an accepted prerogative of the teacher which profane hands must not touch. If however, any such salaries as herein proposed for the full professorial rank were actually put in operation there would be some of those concerned with the administrative side of education who would at once raise the question as to whether the permanency feature of the full professor's position might not be omitted with substantial benefit to education. If the remuneration is adequate why should a professor be guaranteed a permanent position irrespective of the manner in which he continues to do his work any more than a man in any other position of responsibility?

D. Personal and Professional Development

The Importance of Practice.—The nature of the teacher's work tends in some measure toward monotony. The constant reiteration of facts and principles to immature students, less wise and experienced than the teacher himself, tends toward pedantry and often develops a false sense of infallibility. Some of these qualities of character and personality which are called into play and developed by work in the practical world outside, lie dormant or tend to atrophy under the conditions that surround the teacher. He is not unlikely to

withdraw himself from the interests and contacts of a world which he is nevertheless preparing his students to enter. To offset these dangers, it is important that the engineering teacher should have every opportunity to secure a sufficient contact with the problems which his brother engineer in practice is working on and with the conditions under which these problems must be solved. He should know from adequate and actual experience what things are done in practice, and how they are done. This will serve to furnish him with a proper perspective not only for his teaching but for the exacting work of research and investigation of a theoretical nature which, we take it, is one of the special functions of the engineering teacher. These contacts also increase his self-respect, the respect in which he is held by his students, and give him a standing in the community which cannot fail to react favorably on his career.

This investigation has shown that engineering schools fully recognize the importance of this. In over two-thirds of them some form of professional practice is encouraged during the academic year and in the remaining third, with a very few exceptions, such practice is at least permitted.

The importance of professional practice during the vacation is also generally recognized and encouraged. Indeed a teacher of engineering subjects who does not utilize some part of his vacation for active professional work of one sort or another is likely to be looked upon with disapproval.

There appears to be no reason to suppose that this professional work, whatever its nature, is regarded as in any way interfering with teaching duties. Where such interference appears it can be effectually controlled. There are of course great variations in the amount done by different individuals, even in a single institution, but judging by the amounts earned it does not appear that on the average there is as much of this work done as is commonly supposed.

Positive Encouragement Justified.—It seems to be clear that it would be advantageous if all engineering schools not only encouraged their teachers to do a reasonable amount of

outside professional work, but actually insisted on it and made a systematic and organized effort to promote it. Such action with reference to the younger teachers before they have become permanently settled in teaching positions would be most beneficial. Particular emphasis may be laid on the importance of such opportunities during vacations, for then is the most favorable time for a satisfactory and mutually advantageous cooperation with industry. The benefit is not confined to the teacher; the industry will profit by the services of men thoroughly masters of theory; the schools will render a correspondingly greater service to the community; the students will discover very quickly that their teachers are not merely teachers but doers, and will respect them accordingly.

It is perhaps needless to qualify these statements by remarking that the character of the work should be such as to provide an experience which will react favorably on the academic work. Mere "pot-boiling" jobs should be avoided.

Sabbatical Leave.—Only a third of the engineering colleges have any definite provisions for sabbatical or other regular leave, and only an insignificant number of engineering teachers avail themselves of the privilege where it exists. The question is obviously not a very live one. Leaves of absence might, however, well be made a more general practice. Such leaves should be granted so that members of the staff could devote themselves to study, research, or professional work calculated to advance their standing and afford them a desirable change of environment. The time of taking the leave and its duration should always be determined on the merits of the individual case.

Exchange of Professors.—Although not touched upon in the questionnaire, the question of exchange of teachers for stated periods between our engineering schools should be considered. The practice is rarely indulged in by the engineering schools although not uncommon between colleges of liberal arts. Several quite obvious advantages both to institutions and the individuals participating would doubtless result from

such exchange, and it is hereby recommended as a subject to be given careful consideration.

Training and Developing of Teachers.—It is felt by many that a good deal could and should be done in the matter of training younger teachers. There is evidently a good deal of very honest and well founded scepticism among the teaching fraternity as to whether one can be taught how to teach. A great many express such opinions as "teachers are born not made;" "you are a good teacher or you are not;" "one has to learn by experience, by trial and error;" "schools must find out who is successful and who is not, and act accordingly," and the like.

There is doubtless much truth in all this, but even those who are *born* teachers can be *made better* teachers by direct instruction in the art of teaching. All those who have to act on the administrative side of education are painfully aware of the injustice that is inflicted on the student, particularly in elementary but basal courses where the instruction is even in part in the hands of inadequately trained teachers. This is probably in part unavoidable but there is certainly too little close supervision of young teachers and too little direct training.

In the first place something can be done by way of developing the value of the departmental meetings which are held generally throughout our engineering schools. If these conferences are held frequently enough and include discussions of the content of the courses offered by the department, the methods of presentation and marking, and the best possible correlation with related subjects both within and without the department, they are extremely valuable to the younger teacher. Too much standardization however should be avoided in order to preserve individual initiative and inventiveness.

It is believed that the younger teachers might with advantage visit the classroom exercises of the older and more experienced teachers more generally than they do at present. Whether the more experienced teachers who have charge of

the various courses could with equal advantage follow the practice of visiting classrooms of young teachers is not perhaps so clear. It is difficult for most young teachers, unless they are dangerously self-confident, not to say conceited, to carry through a lecture or recitation with any justice to themselves if a more experienced teacher suddenly appears in their classroom. The reaction on the students may also be unfortunate. However, it seems certain that if the element of embarrassment could be removed, the more experienced teachers could secure through such classroom visits first-hand knowledge of the inadequacies of the younger teachers and would as a result be in a position to help them very materially by constructive criticism and suggestions. If it were a generally accepted practice in all schools for those in charge to visit at regular intervals the classrooms of the younger men, and if this were done in a kindly and tactful manner it is probable that there would be no serious embarrassment to either teacher or students and that very substantial benefits would result.

Where a competent teacher of psychology and of the general principles of teaching is available every young teacher and many older ones would profit materially by attending his classes. Some even go so far as to believe that a little elementary instruction in the use of the voice and in classroom manners would be a good thing.

A Qualifying Period of Practice.—The importance of professional work of one kind or another in the development of the engineering teacher and the wholesome practice of drawing to our staffs a considerable number of engineers from practice have been noted. Many in the engineering profession believe that no man should be appointed to a permanent position on an engineering faculty unless he has had several years of actual engineering practice quite aside from any professional experience incidental to teaching work. They insist that after a few years of teaching experience following the completion of his formal education the young instructor or assistant professor should devote himself to engineering

practice for several years as a vital part of his training leading toward a later career as a teacher. There are obviously strong arguments in favor of such a practice. In general adoption is not practicable perhaps at present and it may never be wise to insist on it for all teachers, but it is a matter that should be given very careful consideration, for few will be disposed to deny that the engineering teacher who has had the experience of actual practice possesses a background and point of view which can hardly fail to make him a more successful instructor of young men who are being prepared for engineering work.

E. Conclusion

There will be little disagreement with the statement that the real problem before us is that of securing the right type of teachers for our engineering faculties—that this constitutes a major problem in engineering education. On it hangs the satisfactory solution of our most serious educational difficulties. It has been well said that engineering education will never be better than its teachers. The data presented are, we believe, furnishing us with a reliable basis of fact which will help materially in deciding the future course of action in this vital matter.

PART III. TABULAR SUMMARY OF DATA

1. Sources from which Teachers were Obtained.

(Figures Give the Numbers Obtained from Each Source during the Calendar Years 1920 to 1924 Inclusive.)

Rank.		By Promotion in Staff of Same Institution.	From Staff of Another Institution.	From Graduating Class of Same Institution.	From Graduating Class of Another Institution.	Total from Teaching Staffs or Graduating Classes Cols. 2 to 5 Incl.	From Engineering Practice.	From Other Sources.	Totals Cols. 6 to 8 Inc.	Present Numbers of Each Rank in Institutions Represented.
(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Dean:	No.	16	12			28	4		32	70
	%	*50.0*	*37.5*			*87.5*	*12.5*			
Professor:	No.	83	47			130	37	8	175	487
	%	*47.4*	*26.8*			*74.3*	*21.2*	*4.6*		
Associate Professor:	No.	104	30			134	34		168	207
	%	*61.9*	*17.9*			*79.8*	*20.2*			
Assistant Professor:	No.	163	112	14	5	294	79	7	380	376
	%	*42.9*	*29.4*	*3.8*	*1.3*	*77.4*	*20.8*	*1.8*		
Instructor:	No.	57	178	223	117	575	334	59	968	630
	%	*5.9*	*18.4*	*23.1*	*12.1*	*59.4*	*34.5*	*6.0*		
Assistant:	No.		9	26	21	56	21	2	79	94
	%		*11.4*	*32.9*	*26.6*	*70.9*	*26.6*	*2.5*		
Others:	No.	1	18	26	1	46	19	17	82	84
	%	*1.2*	*22.0*	*31.7*	*1.2*	*56.1*	*23.2*	*20.7*		
Total	No.	424	406	289	144	1,263	528	93	1,884	1,948
	%	*22.6*	*21.6*	*15.3*	*7.6*	*67.1*	*28.0*	*4.9*		

2. Loss of Teachers During the Five-Year Period 1920 to 1924 Inclusive.

Rank.	Left to Take Another Teaching Position.	Per Cent.	Left to Enter Field of Engineering Practice.	Left to Enter Business.	Left to Enter Other Fields.	Total Losses for 5 Year Period Cols. 4, 5 and 6.	Percentage Loss of Each Rank Per Year.	Present Total Numbers in Institutions Represented.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dean	6	1.7	4	3	4	11	3.1	70
Professor	36	1.5	36	7	15	58	2.4	487
Associate Professor	21	2.0	25	5	2	32	3.1	207
Assistant Professor	67	3.6	57	22	11	90	4.8	376
Instructor	171	5.4	274	65	70	409	13.0	630
Assistant	19	4.0	23	1	8	32	6.8	94
Others	8	1.9	16	3	5	24	5.7	84
Totals	328	3.4	435	106	115	656	6.7	1,948
Percentage per year of present total number of teachers	3.37		4.46	1.09	1.18	6.73		

(Teachers deceased or retired are not included in the tables. Average percentage yearly loss, professorial ranks—3.35 per cent. Average percentage yearly loss, lower ranks—11.5 per cent. Total percentage turnover per year—10.1 per cent.)

3. Academic Salaries and Supplementary Incomes of Teachers of Engineering in the United States and Canada.

2,279 Individuals Reporting.

Years Since First Degree was Obtained, as of June, 1925.

75 Institutions Represented, as Follows:

23 in New England and Middle Atlantic States,
10 in Rocky Mountain States,
4 in Pacific Coast States,
5 in Canada,
13 in Southern States,
20 in Middle Western States.

(Supplementary income includes all income not derived from academic salary or from inheritances or gifts.)

Years Since First Degree was Obtained.	Total Number Reporting.	Individuals Reporting Supplementary Incomes.		Annual Academic Salaries.		Median Annual Supplementary Incomes of those Reporting Same.	Annual Total Incomes.	
		Number.	Per Cent.	Median.	Most Frequent.		Median of those Reporting Supplementary Incomes.	Median, All Individuals Included.
1	76	53	69.8	$1,500	$1,800	$ 300	$1,900	$1,750
2	115	71	61.7	1,700	1,800	400	2,000	1,900
3	101	59	58.5	1,800	2,000	325	2,100	2,000
4	110	65	59.0	1,900	1,800	393	2,400	2,200
5	108	69	63.9	2,000	*1,800–2,000	483	2,700	2,400
6	83	59	71.1	2,225	2,000	550	2,900	2,675
7	75	55	73.4	2,200	2,000	500	2,850	2,700
8	93	64	68.9	2,400	2,400	600	3,100	2,850
9	71	53	74.6	2,400	*2,400–3,000	600	3,075	3,000
10	118	91	77.1	2,550	3,000	625	3,300	3,075
11	83	66	79.5	2,800	2,700	679	3,550	3,300
12	75	60	80.0	2,850	2,500	700	3,750	3,550
13	61	51	83.6	3,000	3,000	600	3,550	3,500
14	90	80	88.9	3,000	3,000	600	3,525	3,450
15	81	69	85.2	3,000	3,000	795	3,900	3,800
16	63	48	76.2	3,000	2,800	800	4,150	4,000
17	82	73	89.0	3,200	3,000	600	4,000	4,000
18	70	63	90.0	3,300	3,000	880	4,200	4,050
19	61	53	87.0	3,600	4,000	720	4,850	4,550
20	86	77	89.6	3,500	4,000	1,200	4,875	4,600
21	43	37	86.1	3,625	*3,500–5,000	1,000	4,900	4,500
22	52	42	80.8	3,500	*3,000–4,000	1,210	4,800	4,700
23	35	30	85.7	4,000	4,000	1,350	5,400	5,250
24	52	45	86.5	3,700	3,500	1,000	4,750	4,500
25	42	38	90.5	3,600	4,000	1,000	4,600	4,500

TABLE 3.—*Continued.*

Years Since First Degree was Obtained.	Total Number Reporting.	Individuals Reporting Supplementary Incomes.		Annual Academic Salaries.		Median Annual Supplementary Incomes of those Reporting Same.	Annual Total Incomes.	
		Number.	Per Cent.	Median.	Most Frequent.		Median of those Reporting Supplementary Incomes.	Median, All Individuals Included.
26	25	24	96.0	4,300	*4,500–5,000	1,550	5,300	5,250
27	26	26	100.0	4,225	*3,500–4,500	1,700	5,750	5,750
28	25	22	88.0	4,500	5,000	1,475	5,700	5,550
29	34	31	91.3	4,000	4,500	1,375	5,850	5,500
30	47	37	78.7	4,400	5,000	1,700	6,700	5,600
†31	25	22	88.0	4,225	*4,500–5,000–6,000	1,550	6,000	5,825
†32	21	21	100.0	4,200	5,000	1,800	6,550	6,000
†33	15	12	80.0	4,225	4,000	1,350	6,000	5,825
†34	22	20	91.0	4,275	4,500	1,650	6,000	5,725
†35	21	18	85.7	4,400	4,500	1,377	6,000	5,600
†36	11	10	91.0	4,500	4,500	1,200	5,650	5,150
†37	12	10	83.3	4,500	4,500	1,000	5,500	5,400
†38	11	10	91.0	4,500	4,500	1,333	6,000	5,950
†39	10	9	90.0	4,650	*4,500–6,000	1,402	6,600	6,000
†40	14	13	93.0	4,800	6,000	1,775	6,800	6,600
†41	7	6	85.7	5,000	6,000	2,100	7,500	7,250
†42	6	6	100.0	4,800	6,000	2,000	6,800	6,600
†43	5	4	80.0	5,000	6,000	1,800	7,500	6,400
†44	3	2	66.7	4,800	6,000	3,000	6,000	6,000
†45	1	1	100.0	4,500	*3,000–4,000 5,000–6,000	2,100	6,250	6,500
46	2	2						
47	4	3						
48	2	2						
49	1	1						
50	0	0						
51	1	1						
52	0	0						
53	1	1						
54	0	0						
55	1	0						

Medians have not been computed because of small number of individuals.

* Equal numbers of salaries of amounts shown reported.

† Medians computed for five-year period.

4. MAXIMUM AND MINIMUM ACADEMIC SALARIES REPORTED.
(2,279 Individuals in 75 Institutions Included.)

Years Since First Degree was Obtained.	Maximum Academic Salary Reported.	Minimum Academic Salary Reported.	Years Since First Degree was Obtained.	Maximum Academic Salary Reported.	Minimum Academic Salary Reported.	Years Since First Degree was Obtained.	Maximum Academic Salary Reported.	Minimum Academic Salary Reported.
1	$2,400	$ 500	16	$6,000	$1,800	31	$8,000	$2,200
2	3,050	750	17	6,000	1,800	32	7,000	3,000
3	3,000	600	18	7,000	1,600	33	6,000	2,400
4	4,000	800	19	6,000	1,650	34	7,200	2,600
5	3,800	500	20	7,000	2,000	35	7,000	2,000
6	3,600	1,200	21	6,000	2,000	36	7,000	2,100
7	4,000	800	22	7,000	2,000	37	6,000	2,400
8	4,900	1,500	23	6,500	2,600	38	6,300	3,500
9	3,800	800	24	6,300	2,000	39	8,000	2,250
10	5,000	1,400	25	8,000	1,800	40	7,500	2,400
11	5,000	1,500	26	6,000	2,800	41	7,200	4,200
12	5,000	1,800	27	7,500	1,800	42	6,000	1,800
13	4,500	800	28	7,000	2,600	43	5,000	3,500
14	6,000	1,500	29	7,500	2,400	44	6,000	3,000
15	6,000	1,600	30	10,000	1,500	45	4,000	4,000

5. SUMMARY OF SALARY SCALES IN 69 REPRESENTATIVE INSTITUTIONS.

Rank.	No. of Each Rank	Maximum.	Minimum.	Median.	Most Frequent.
Dean	54	$10,000	$2,500	$5,000	$5,000
Professor	700	7,500	2,500	4,000	4,000
Associate Professor	350	6,000	2,000	3,300	3,500
Assistant Professor	539	5,000	1,500	2,700	2,500
Instructor	831	3,000	900	2,000	2,000
Assistant	137	2,400	250	800	800
"Associate"	20	4,500	2,200	2,500	2,500
TOTAL	2,631				

6. COMPARISON OF SALARIES AND TOTAL EARNINGS OF ENGINEERING TEACHERS WITH EARNINGS OF ENGINEERING GRADUATES IN PRACTICE.

(Values taken from smooth curves.)

Years After Graduation.	Median Annual Academic Salaries of Teachers.	Median Total Annual Earned Income of Teachers.	Median Total Annual Earnings of Graduates.	Ratio: Salary of Teachers to Earnings of Graduates.	Ratio: Total Income of Teachers to Earnings of Graduates.
0*	$1,500	$1,500	$1,475	1.02	1.02
1	1,500	1,750	1,800	.83	.97
2	1,700	1,900	2,100	.81	.905
5	2,000	2,350	2,860	.70	.82
10	2,550	3,100	4,000	.64	.775
15	3,100	3,825	5,000	.62	.765
20	3,600	4,500	5,900	.61	.76
30	4,225	5,550	7,500	.56	.74

* First appointment.

7. DISTRIBUTION OF TEACHERS OF VARIOUS RANKS AND TOTAL NUMBER OF HOURS PER WEEK OF TEACHING DUTIES CARRIED.

(Only teachers reporting to the Dean of Engineering are included.)

	No. of Teachers of Each Rank.	Per Cent. of Total No. of Teachers.	Per Cent. of Total Load Carried.	Load—No. of Hours* per Individual per Week.
Deans or Directors	81	3.5	1.7	8.4
Professors	565	24.7	24.0	17.2
Associate Professors	269	11.7	11.8	17.6
Assistant Professors	472	20.6	21.7	18.6
Instructors	767	33.5	35.0	18.4
Assistants	95	4.2	4.5	19.3
Other ranks (Associates, etc.)	40	1.8	1.3	13.6
TOTALS	2,289	100.0	100.0	Av. 17.6

* An "hour" is a college period of from 50 to 55 minutes.

8. Distribution of Teaching Duties in Hours* per Week for Teachers of Each Rank.
(Only teachers reporting to the Dean of Engineering are included.)

Rank.		Lectures and Recitations.		Drafting and Design.		Laboratory and Field.		Shop.	Graduate Courses.	Research Work.	Total.
		Junior and Senior.	Fresh. and Soph.	Junior and Senior.	Fresh. and Soph.	Junior and Senior.	Fresh. and Soph.				
Deans or Directors	Hours...	3.89	1.01	0.73	0.42	0.81	0.47	0.05	0.44	0.61	8.43
	Per Cent.	*46.1*	*12.0*	*8.6*	*5.0*	*9.6*	*5.6*	*0.6*	*5.3*	*7.2*	*100.0*
Professors	Hours...	5.7	1.8	2.5	0.7	2.8	0.9	0.3	1.0	1.5	17.2
	Per Cent.	*33.1*	*10.3*	*14.6*	*4.2*	*16.2*	*5.1*	*1.8*	*5.8*	*8.9*	*100.0*
Associate Professors	Hours...	4.7	2.3	2.0	1.2	4.0	1.3	0.06	0.8	1.2	17.6
	Per Cent.	*26.9*	*13.3*	*11.3*	*7.0*	*22.6*	*7.5*	*0.3*	*4.5*	*6.6*	*100.0*
Assistant Professors	Hours...	3.7	2.7	1.3	2.1	4.2	2.0	1.0	0.4	1.2	18.6
	Per Cent.	*20.2*	*14.4*	*6.9*	*11.3*	*22.3*	*10.7*	*5.6*	*2.3*	*6.3*	*100.0*
Instructors	Hours...	2.0	3.2	0.8	2.5	3.4	2.7	2.9	0.1	0.8	18.4
	Per Cent.	*10.8*	*17.5*	*4.4*	*13.6*	*18.5*	*14.4*	*15.9*	*0.7*	*4.2*	*100.0*
Assistants	Hours...	0.3	0.6	0.6	1.9	3.6	2.2	5.7		4.4	19.3
	Per Cent.	*1.6*	*3.5*	*3.0*	*9.7*	*18.6*	*11.5*	*29.5*		*22.6*	*100.0*
Other ranks	Hours...	0.1	0.7		0.2	2.7	3.9		0.3	5.7	13.6
	Per Cent.	*1.1*	*4.8*		*1.5*	*20.0*	*28.3*		*2.2*	*42.1*	*100.0*
Average—All ranks combined	Hours...	3.6	2.4	1.4	1.7	3.4	1.8	1.5	0.5	1.3	17.6
	Per Cent.	*20.2*	*13.7*	*8.1*	*9.6*	*19.1*	*10.4*	*8.6*	*2.8*	*7.5*	*100.0*
Total—Deans not included	Hours...	3.5	2.5	1.5	1.7	3.5	1.9	1.6	0.5	1.3	18.0
	Per Cent.	*19.4*	*13.9*	*8.3*	*9.5*	*19.4*	*10.6*	*8.9*	*2.8*	*7.2*	*100.0*

* An "hour" is a college period of from 50 to 55 minutes.

9. Division of Various Types of Instruction of Upper and Lower Classes among Teachers of Various Ranks.

(Instruction given by teachers who do not report to the engineering dean is not included in the table.)

Rank.	Teachers of Each Rank, %.	Lectures and Recitations.		Drafting and Design.		Laboratory and Field.		Shop, %.	Graduate Courses, %.	Research Work, %.	Total. %.
		Jun. and Senior, %.	Fresh. and Soph., %.	Jun. and Senior, %.	Fresh. and Soph., %.	Jun. and Senior, %.	Fresh. and Soph., %.				
Deans or Directors	3.5	3.9	1.5	1.8	0.9	0.9	0.9	0.1	3.2	1.6	1.7
Professors	24.7	39.4	18.1	43.0	10.6	20.4	11.7	5.1	49.7	28.6	24.0
Associate Professors	11.7	15.7	11.4	16.4	8.6	13.8	8.5	0.4	19.3	10.4	11.8
Assistant Professors	20.6	21.7	22.8	18.4	25.6	25.3	22.3	14.2	17.5	18.3	21.7
Total professorial rank	60.5	80.7	53.8	79.6	45.7	60.4	43.4	19.8	89.7	58.9	59.2
Instructors	33.5	18.8	44.6	18.7	49.5	33.8	48.0	64.7	9.2	19.7	35.0
Assistants	4.2	0.4	1.1	1.7	4.6	4.4	5.0	15.5		13.8	4.5
Other ranks	1.8	0.1	0.5		0.2	1.4	3.6		1.1	7.6	1.3
Total: Instrs., Assts. and others	39.5	19.3	46.2	20.4	54.3	39.6	56.6	80.2	10.3	41.1	40.8
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

10. CONDENSED SUMMARY OF DATA SHOWN IN TABLES 7, 8, AND 9.

Rank.	Teachers of Each Rank.		Lectures and Recitations.				Drafting and Design.				Laboratory and Field.			
			Jun. and Senior Hours.		Fresh. and Soph. Hours.		Jun. and Senior Hours.		Fresh. and Soph. Hours.		Jun. and Senior Hours.		Fresh. and Soph. Hours.	
	No.	%.	No.	%.	No.	%.	No.	%.	No.	%.	No.	%.	No.	%.
Deans or Directors	81	3.5	315	3.9	82	1.5	59	1.8	34	0.9	66	0.9	38	0.9
%				46.1		12.0		8.6		5.0		9.6		5.6
Professors	565	24.7	3214	39.4	1001	18.1	1410	43.0	410	10.6	1574	20.4	495	11.7
%				33.1		10.3		14.6		4.2		16.2		5.1
Associate Professors	269	11.7	1278	15.7	631	11.4	537	16.4	331	8.6	1070	13.8	357	8.5
%				26.9		13.3		11.3		7.0		22.6		7.5
Assistant Professors	472	20.6	1768	21.7	1263	22.8	603	18.4	988	25.6	1955	25.3	940	22.3
%				20.2		14.4		6.9		11.3		22.3		10.7
Instructors	767	33.5	1532	18.8	2474	44.6	615	18.7	1918	49.5	2612	33.8	2026	48.0
%				10.8		17.5		4.4		13.6		18.5		14.4
Assistants	95	4.2	30	0.4	63	1.1	55	1.7	178	4.6	341	4.4	210	5.0
%				1.6		3.5		3.0		9.7		18.6		11.5
Other ranks	40	1.8	6	0.1	26	0.5			8	0.2	109	1.4	154	3.6
%				1.1		4.8				1.5		20.0		28.3
TOTALS	2289	100.0	8143	100.0	5540	100.0	3279	100.0	3867	100.0	7727	100.0	4220	100.0
%				20.2		13.7		8.1		9.6		19.1		10.4

TABLE 10. *Continued.*

Rank.	Teachers of Each Rank. No.	Teachers of Each Rank. %.	Shop Hours. No.	Shop Hours. %.	Graduate Course Hours. No.	Graduate Course Hours. %.	Research Work Hours. No.	Research Work Hours. %.	Total Hours. No.	Total Hours. %.	Hours per Individual per Week.
Deans or Directors	81	3.5	4	0.1	36	3.2	49	1.6	683	1.7	8.43
%				0.6		5.3		7.2		100.0	
Professors	565	24.7	178	5.1	557	49.7	860	28.6	9699	24.0	17.2
%				1.8		5.8		8.9		100.0	
Associate Professors	269	11.7	15	0.4	216	19.3	314	10.4	4749	11.8	17.6
%				0.3		4.5		6.6		100.0	
Assistant Professors	472	20.6	492	14.2	196	17.5	551	18.3	8756	21.7	18.6
%				5.6		2.3		6.3		100.0	
Instructors	767	33.5	2244	64.7	103	9.2	590	19.7	14114	35.0	18.4
%				15.9		0.7		4.2		100.0	
Assistants	95	4.2	540	15.5			415	13.8	1832	4.5	19.3
%				29.5				22.6		100.0	
Other ranks	40	1.8			12	1.1	229	7.6	544	1.3	13.6
%						2.2		42.1		100.0	
TOTALS	2289	100.0	3473	100.0	1120	100.0	3008	100.0	40377	100.0	17.6
%				8.6		2.8		7.5		100.0	

11. SUMMARY OF DEGREES HELD BY TEACHERS OF ENGINEERING STUDENTS.

(143 Institutions Included.)

Degrees.	Teachers of Engineering Subjects Including Mechanics.		Teachers of Chemistry and Chemical Engineering.		Teachers of Sciences, Including Mathematics.		Teachers of English and Modern Languages.		Teachers of Economics and Business.	
	No.	%.	No.	%.	No.	%.	No.	%.	No.	%.
Dr. Eng.	15	0.40	1	0.01	0	0.00	0	0.00	0	0.00
Dr. Sc.	66	1.79	43	2.83	66	2.65	3	0.12	3	0.29
Ph.D.	95	2.57	484	31.76	601	24.56	502	20.37	197	19.74
Professional degrees, C.E., E.E., M.E., etc.	1,086	29.40	41	2.68	131	5.24	5	0.21	22	2.20
M.S. with specification as M.S. in C.E.	109	2.95	12	0.78	11	0.35	1	0.05	1	0.10
M.S. without specification	245	6.64	267	17.49	254	10.12	17	0.69	23	2.30
B.S. with and without specification	1,113	30.14	199	13.09	267	10.71	70	2.85	73	7.39
A.B., Ph.B., etc.	232	6.28	186	12.18	487	19.85	791	32.09	250	25.03
M.A.	116	3.15	207	13.56	517	20.06	859	34.83	251	25.13
L.L.D., Litt.D., etc.	19	0.51	14	0.91	47	1.87	53	2.15	24	2.42
Other degrees	76	2.06	48	3.14	72	2.96	121	4.90	138	13.82
No degrees	521	14.10	24	1.57	41	1.63	43	1.74	16	1.59
Total number of degrees	3,693		1,526		2,494		2,465		998	
Total number of teachers	3,159		1,086		1,852		1,835		666	

12. Policies of Institutions as to Participation of Teachers in Engineering Practice During the College Year.

		State Universities.	Land Grant Colleges.	State Schools of Mines.	State Military Colleges.	Municipal Institutions.	Privately Endowed Universities.	Privately Endowed Polytechnic Institutes.	Privately Endowed Arts Colleges.	Canadian Institutions.	Hawaiian Institutions.	Totals.
Outside work permitted	No.	33	12	6	2	2	27	12	9	7	1	111
	%	*91.7*	*85.7*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*95.7*
Outside work not permitted	No.	3	2									5
	%	*8.3*	*14.3*									*4.3*
Outside work encouraged	No.	18	5	5	1	1	21	9	9	6	1	76
	%	*50.0*	*35.7*	*83.3*	*50.0*	*50.0*	*77.8*	*75.0*	*100.0*	*85.8*	*100.0*	*68.5*
Outside work tolerated	No.	14	6	1	1		6	2				30
	%	*38.9*	*42.9*	*16.7*	*50.0*		*22.2*	*16.7*				*27.0*
Outside work discouraged	No.	1	1			1						3
	%	*2.8*	*7.1*			*50.0*						*2.7*
Not answering	No.							1		1		2
	%							*8.3*		*14.2*		*1.8*
Number of institutions of each type		36	14	6	2	2	27	12	9	7	1	116

13. Limitations as to Amount and Character of Outside Work.

Nature of Limitation.

	Number of Institutions.
Outside work must be of a consulting nature only and must advance the teacher's professional standing	15
Permission of President or Trustees must be obtained	6
Permission of Dean or Director of Department must be obtained	8
Not less than two-thirds of teacher's time must be devoted to the institution	1
Teacher may give approximately one-eighth of time to outside work	1
There must be no direct competition with local practicing engineers (Municipal Institution)	1
Outside office must not be maintained	1
One-half of income derived from outside work goes to the institution	1

Arrangements for Use of Laboratory Equipment by Teachers in Connection with Outside Work.

	Number of Institutions.
Materials, power, etc. used must be paid for	49
Fee is paid for use of laboratory	43
No specific arrangement	13
Use of laboratories not permitted	3
No reply	3

Limitation on Use of the Name of the Institution in Connection with Outside Work.

	Number of Institutions.
None, but the school is not responsible for the results	23
Professor may state his connection with the school	12
Professor must not state his connection with the school	65
No specific regulations, each case decided on its own merits, and miscellaneous replies	6
No reply	5

ENGLISH AND TECHNICAL COÖRDINATION AT THE UNIVERSITY OF NORTH CAROLINA.

BY LOUIS B. WRIGHT,

Chairman Freshman Engineering English.

Coördination between the technical departments and the English department in the teaching of English composition has probably been carried further in freshman instruction in the University of North Carolina School of Engineering than in most engineering schools. All of the English work of the first year is arranged to lead up to a coöperative course in the spring quarter in which the student receives both technical and English credit for the same work. In view of the recent discussions of the feasibility and value of coördination, the methods employed at the University of North Carolina may be of interest.

Adequate coördination requires more time from the English department and necessitates a larger staff than would be necessary otherwise, but after a careful study of the results, Dean G. M. Braune is convinced that the economic saving for the student justifies a staff large enough not only to insure coördination with the technical departments but also to maintain the conference system of instruction.

The freshman English course is divided into three quarters designated as English 9*a*, 9*b*, and 9*c*. In English 9*a* in the fall quarter, students are given a review of the fundamentals of grammar and the mechanics of writing. The class has two one-hour meetings each week, and each student has a weekly conference period with the instructor of not less than fifteen minutes. One long theme on some semi-technical subject is required each week in addition to short papers. Laboratory reports, instead of being returned to the students, are sent to the English department. In the conference period each week, the English of the reports is criticized, and the instructor goes

over carefully the mistakes in all of the student's papers. In addition to laboratory and theme material, students are required to bring weekly chemistry quiz books, which are criticized. The instructor endeavors to impress on the student that whenever he writes, he is writing English which should be correct. Examples of incorrect sentences culled from quiz books and laboratory reports are used for class analysis in addition to the regular text-book material in grammar and mechanics.

From the first theme, all papers in English, even quizzes and exercises, take the technical report format in order to teach the student the value of neatness and orderly arrangement. After the preliminary papers, topical outlines, marginal outlines, and letters of transmittal are required with each long English report.

During the winter quarter, conferences are lengthened, and greater attention is paid to the organization of both technical and English reports. Illogical organization in technical reports is pointed out by the English instructor. Students are required to hand in a list of their courses, and theme subjects allied with their technical work are assigned. For example, if a civil engineering student is taking a cement laboratory course, he will be assigned technical descriptions of cement testing apparatus, process expositions of the manufacture of cement or of methods of laying concrete pavement, etc. An occasional conference between English and technical instructors may furnish suggestions for paper subjects. Students are also encouraged to write reports of engineering projects in which they have had practical experience.

By the beginning of the spring quarter, the student is prepared for the course in report writing which is given in coöperation with the technical departments. Students register for Engineering 7*c* and English 9*c* and receive both technical and English credit for the same work. This dual course consists of inspection trips made to nearby engineering projects and detailed reports on these trips. The technical departments furnish the student with a syllabus containing ques-

tions, suggestions, etc. A technical lecture is given on the trip, and an English instructor attends in order to have an intelligent understanding of the purpose of the report.

Students hand in the reports first to the English department. Organization of the report is studied in class. In the thirty-minute conference period each week, the student's individual errors are pointed out. Students are required to revise their reports and hand them back to the English department, which turns them over to the technical departments after seeing that proper revisions have been made.

Experience has shown that the reports are technically better when the students are consciously careful about their English. The insistence by English instructors on accuracy and clarity makes the reports worth more technically; the interest which the students have in a technical subject increases their value as English papers; for however much one may emphasize the value of English as a cultural study, the average engineering student regards it as a purely utilitarian course, and he does better work when he sees its practical application. Far from destroying the individuality of English, the North Carolina plan of coördination turns the field of the student's greatest interest into the channel of study of English. The English department capitalizes on technical interest, and the technical departments profit by an increase in accuracy and clearness of expression in purely technical work. Furthermore, diffusion of effort and waste of energy on the part of the student is eliminated by this close coördination. Through it, the engineering student completes his first year with a realization of the practical value of English and a knowledge of the essentials of clear, accurate, convincing technical writing.

THE ENGLISH DEPARTMENT.

Report of Committee No. 12.

Note: This report was read at the meeting of the Society at Iowa City.

It is now five years since the Committee on English first called together—on the occasion of the annual meeting of the Society for the Promotion of Engineering Education—teachers of English and others interested, to consider together the place of training in English in the preparation of engineering students for their professional work.

The response at that time showed how vital an interest had been touched upon. Thirty-nine schools were represented at that conference and, most significant of all, more than one half of those present were deans, heads of technical departments and teachers of engineering subjects. During the five years that have intervened, definite progress has been made. The mere fact that nearly one hundred members of this Society came together a half day in advance of the opening session indicates how genuine the interest is in the field of our particular research. That most of these were deans and administrative officers representing forty-five colleges and institutions demonstrates still further the growth in interest in the problem of securing adequate training in English for our students.

The discussion at the joint meeting of the deans and teachers of English, while primarily directed to the consideration of the extension of courses in English, especially by the development of elective courses in English literature, gave evidence that in the minds at least of those so largely responsible for our destinies, there is a clearing up of many points of confusion, a growing agreement as to objective and a wholehearted willingness to coöperate that pressages much for the future.

In the first place, the importance of training in English as a part of the student's preparation for his work and for life is so universally recognized as to need no further demonstration.

In the second place, the two-fold purpose of such training is so clearly seen that it can be stated in as simple terms as these:

(*a*) To develop in the student habits of correct English usage, to give him ability to write and to speak as an educated and cultured man should.

(*b*) To give him a genuine interest in good books, an appreciation of the best, and some ability to discriminate between the worthy and the mediocre, that is, to make his reading a matter of habit, an end to be pursued with systematic effort.

In the third place, the responsibility of establishing habits of correct speech and of intelligent reading must clearly be shared by all who come in contact with the student or who contribute to his training. There is evident a desire on the part of the deans and teachers of engineering subjects to share this responsibility and to coöperate with the teachers of English.

The Committee on English cannot claim perhaps to be in any large measure responsible for clearing up the confusion of opinion that formerly surrounded this subject of English as a part of the engineering curriculum nor in crystallizing the sentiment of those most concerned, but it is happy to have had its part. As it understands the ideals and policies of the leaders in engineering education, it assures them of its enthusiastic coöperation.

J. Raleigh Nelson, *Chairman*,
W. Otto Birk,
S. A. Harbarger,
K. O. Thompson,
F. E. Seavey.

DISCUSSION.

"The Engineering Course as a General Education," E. Willis Whited, Journal of Engineering Education, May, 1926.

BY FREDERIC N. WEAVER,

Assistant Professor of Civil Engineering, Tufts College, Mass.

Mr. Whited's article exemplifies aptly what is perhaps the most significant trend of our times. If anything whatsoever is difficult, evade it. Better still, ignore it. If there is no royal road to geometry, pooh pooh for geometry! We'll take anthropology. Why spend years acquiring a liberal education, why go to college at all, when fifteen minutes a day with Elbert Hubbard's Scrapbook or the Alexander Hamilton Institute Course will give the same results? Why read masterpieces of literature in all their interminable lengths when we can carry in our vest pockets the gist, the really worth while extracts,—that is, the quotable lines? If sound training in engineering necessitates arduous discipline, tireless perseverance, we'll substitute the handbook. Something for nothing! Synopses, epitomes, outlines, summaries, these are the keynotes of the day. Synthetic literature, French in ten lessons, book reviews in place of the books themselves, the ability to chatter superficially on any subject, to select formulas with ease, these are the essentials. Why be thorough when the froth suffices?

Applying the same sound theory to engineering education, let us substitute commercial law for the calculus on the ground that mathematics is difficult, that the students do not like it—claiming, it is true, that commercial law will give better mental training together with a fund of more useful information. This is the claim, but does anyone seriously accept it? Undoubtedly another "cinch" course would be

added to the curriculum. To explain. Mr. Whited propounds a syllogism: Lawyers are admittedly well trained men; they have developed their superiorities by studying law; therefore, if we study law, we shall be equally well trained. The fallacy lies in supposing that in a semester or two we can obtain the results that come only from three years of intensive specialization added to a liberal arts education as a base.

A course in law is not the magic word that makes lawyers logicians; a course in medicine is not the magic word that makes good doctors; and a course in the calculus is not the magic word that makes competent engineers, but to achieve success in any field involves, even in this day of royal roads, sound and careful preparation, solid fundamentals, study, self-denial; and to mistake the name for the deed is still to be living in the age of magic. Edison says, in substance, "There is no labor to which a man will not go to avoid the still more irksome labor of thinking," and, to my mind, substituting commercial law for the calculus gives color to this statement.

The question is pressed, Why require the calculus at all, since only ten per cent of the graduates use it afterward?—if I understand the somewhat obscure statistical paragraph. One can study strength of materials and theoretical mechanics without even referring to the calculus. True. Then why insist on using in? The formulas are all in the book. Why not use them directly? Thus Mr. Whited's article is the frankest plea for the Handbook Engineer that has ever come to my notice. Admitting that fifty per cent of our graduates will never be more than handbook engineers, why set that as the goal for all? Any man so inclined may attend the evening schools, where all the necessarily restricted time must be devoted to so-called practical matters.

As to the engineering curriculum, while admitting that the chosen ten per cent might possibly have foresight and courage enough to elect adequate mathematics, we must also consider the following: To prepare for life we should really prepare for life. The young man entering engineering does not know

how much mathematics he will need, how far he will go, whether he will ever specialize or not; but he matriculates, trusting the college to give him the necessary preparation. Suppose he enters engineering practice, finds that he must know certain advanced phases, finds that the handbook is insufficient? He must then study the calculus by himself, take another year in college, or resign himself to mediocrity. Such a semi-education would be a betrayal of trust on the part of the college. More men bewail their lack of preparation in mathematics than complain of having had too much. It is a simple matter to take the calculus at the start, difficult indeed to pick it up later.

No. Commercial law is a useful subject, but, unlike the calculus, it is far from being a fundamental prerequisite to engineering training. It is a corollary, a postscript, something to be added when needed; and as it can easily be added, whereas calculus can not, common sense dictates its relegation to a subordinate position. Furthermore, the calculus, the most elegant tool of the engineer, necessary to a full comprehension of mechanics, essential in derivation of the laws of all branches of engineering vital to any advances beyond the most elementary stages, is still a necessity, still a paramount importance in the engineering curriculum.

To summarize in a word: We have the trained, intelligent, purposive engineer, prepared for all eventualities, versus the handbook engineer, dependent upon formulas. And when there is a misprint in the formula, Good Heavens! the bridge falls down! Which do we want?

MEETING OF THE COUNCIL.

There will be a meeting of the Council of this Society at the Cosmos Club, Washington, D. C., at 12:30 P.M., Thursday, November 18, 1926. Luncheon will be served.

MEETING OF DEANS AND ADMINISTRATIVE OFFICERS OF ENGINEERING SCHOOLS WITH THE BOARD OF INVESTIGATION AND COÖRDINATION OF THIS SOCIETY.

There will be a meeting of the deans and administrative officers of all engineering colleges with the Board of Investigation and Coördination of this Society in the National Academy of Sciences Building, Washington, D. C., beginning Thursday evening, November 18, and continuing all day Friday, November 19, 1926. The dinner meeting will be a complimentary dinner to the deans and administrative officers and will be held at the New Willard Hotel at 6:30 P.M.

President Frank Aydelotte of Swarthmore College, a member of the Board, will present the subject matter to be discussed at the meeting on Friday. Six specific topics will be presented at the dinner meeting on Thursday evening for discussion and action on Friday.

Deans and administrative officers should return promptly to the Secretary the cards which have been sent with their invitations.

INCREASING THE MEMBERSHIP OF THE SOCIETY.

One member in each institution has been asked to furnish the Secretary with the names and titles of his colleagues who are not members of the Society and whom he thinks might be interested in becoming members. This same procedure was followed last year with a result that over two hundred new members were enrolled. We ask you to assist us.

All applicants, remitting their dues ($4.00) for 1926–27 with their application, will be mailed copies of the back numbers of the 1926–27 JOURNAL OF ENGINEERING EDUCATION. They will then be sure of being fully informed of the results of the three-year investigation of engineering education which the Society has been conducting. The fact-finding stage is finished and the results and recommendations are being published in the JOURNAL.

On page 272, you will find an application blank. Cut it out, hand it to a colleague, wait until he fills it out, then endorse it and mail it at once to the Secretary, Dean F. L. Bishop, University of Pittsburgh, Pittsburgh, Pa.

Society for the Promotion of Engineering Education.

Date.....

THE UNDERSIGNED desiring to become a member of THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION

hereby agrees to conform to the requirements of membership, if elected, and submits the following:

STATEMENT OF QUALIFICATIONS

Full Christian Name and Surname.....

Residence Address (Number and Street).....

Post Office (City and State).....

Full Title of Professional Position.....

Full name of Institution.....

(To be Signed by Two Sponsors).....

SPONSORS {.....
.....

MEMBERSHIP OF THE SOCIETY IN THE DIFFERENT INSTITUTIONS.*

* This list is intended to show *only* the number of members in each institution who are members of the Society. It is not a complete list of the membership since many members of the Society are not connected with schools or colleges.

Institution.	October, 1926.	February, 1925.
Purdue University	59	46
University of Minnesota	58	39
University of Michigan	57	46
The Ohio State University	47	49
University of Illinois	41	43
Pennsylvania State College	29	14
University of Kentucky	27	27
Kansas State Agricultural College	27	24
University of Pittsburgh	26	28
University of Wisconsin	26	24
State University of Iowa	25	23
Yale University	25	30
Iowa State College	24	29
Massachusetts Institute Technology	24	37
Worcester Polytechnic Institute	23	14
Cornell University	23	21
Texas A. & M. College	22	27
Tufts College	22	20
University of Nebraska	21	18
Case School of Applied Science	20	16
Columbia University	18	9
University of Colorado	18	19
University of Maine	17	20
North Carolina State College	17	22
Georgia School of Technology	17	15
Carnegie Institute of Technology	17	16
Harvard University	15	14
New York University	14	16
Michigan State College	13	10
University of Washington	13	11
University of Pennsylvania	13	12
University of Missouri	13	15
Tulane University	12	9

University of Vermont	11	10
Stanford University	11	11
Lehigh University	11	15
University of California	11	18
A. & M. College of Oklahoma	10	1
Rutgers University	10	11
University of Toronto	10	11
University of North Carolina	10	12
Rensselaer Polytechnic Institute	10	13
University of Arizona	9	2
Colorado School of Mines	9	6
University of Texas	9	6
Municipal University of Akron	9	8
Missouri School of Mines	9	8
Syracuse University	9	8
University of Utah	9	8
Stevens Institute of Technology	9	8
Virginia Military Institute	9	10
Washington University (St. Louis)	9	11
Armour Institute Technology	9	11
University of Idaho	8	4
Princeton University	8	6
University of Kentucky	8	6
University of West Virginia	8	7
Michigan College of Mines	8	7
California Institute Technology	8	7
Brooklyn Polytechnic Institute	8	8
University of Delaware	8	8
University of Florida	8	9
Lafayette College	8	10
Oregon Agricultural College	8	10
University of New Hampshire	8	10
Northwestern University	7	8
Union College	7	9
University of Detroit	6	2
Cooper Union	6	3
Montana State College	6	5
Northeastern University	6	5
United States Naval Academy	6	5
University of Oklahoma	6	6
University of Virginia	6	7
Wentworth Institute	6	10
University of Louisville	5	1
South Dakota School of Mines	5	2
Bucknell University	5	2

Marquette University	5	3
Norwich University	5	3
Rice Institute	5	3
Ohio Northern University	5	4
Clemson College	5	4
University of North Dakota	5	5
Pratt Institute	5	5
University of Porto Rico	5	5
University of Nevada	5	5
Johns Hopkins University	5	5
Virginia Polytechnic Institute	5	6
University of Cincinnati	5	7
Duke University	5	7
Brown University	5	7
University of Southern California	4	2
Rhode Island State College	4	2
University of Dayton	4	3
George Washington University	4	3
University of Wyoming	4	4
Washington State College	4	4
University of South Dakota	4	4
Southwestern University	4	5
Colorado Agricultural College	4	5
Alabama Polytechnic Institute	4	5
McGill University	4	7
University of Arkansas	4	7
Texas Technological College	3	0
Ohio Mechanics Institute	3	2
University of Mississippi	3	2
Catholic University of America	3	2
University of Alabama	3	2
Newark Technical College	3	4
Mississippi A. & M. College	2	1
University of Maryland	2	1
La. State University	2	1
Toledo University	2	2
Clarkson College of Technology	2	2
Vanderbilt University	2	2
Gettysburg College	2	2
Rose Polytechnic Institute	2	2
Bradley Polytechnic Institute	2	2
University of Hawaii	2	2
University of British Columbia	2	2
College of the Pacific	2	2
University of Alberta	2	2

University of Tennessee	2	3
Drexel Institute	2	3
La. Industrial Institute	2	3
South Dakota State College	2	4
Antioch College	2	2
Evansville College	1	0
Washington & Lee University	1	1
Denison University	1	1
Rochester University	1	1
Hebrew Institute	1	1
Utah Agricultural College	1	1
The Citadel	1	1
Villanova College	1	1
Girard College	1	1
Haverford College	1	1
New Mexico School of Mines	1	1
Massachusetts Agricultural College	1	1
Colby College	1	1
Trinity College	1	1
University of Saskatchewan	1	1
University of Santa Clara	1	1
Riverside Junior College	1	1
North Dakota Agricultural College	1	2
University of Buffalo	1	2
University of South Carolina	1	2
New Mexico State College	1	2
Swarthmore College	1	3
Darthmouth College	1	3
John B. Stetson University	1	3
University of Denver	1	3

NEW MEMBERS.

ALLEY, ALFRED W., President, Los Angeles Municipal Engineers Association, Los Angeles, Calif.

BOURKE, NORMAN T., Professor and Head, Department, of Mechanical Engineering, University of N. D., Grand Forks, N. D.

BUSBY, HIBBARD S., Director, The A. French Textile School, Georgia School of Technology, Atlanta, Ga.

FRANCISCO, CYRUS P., Junior Civil Engineer, City of Los Angeles, Calif.

GAUSS, HENRY F., Professor and Head, Department, Mechanical Engineering, University of Idaho, Moscow, Ida.

JORGENSON, LOUIS M., Assistant Professor of Electrical Engineering, Kansas State Agricultural College, Manhattan, Kans.

MCCLUSKY, FREDERICK D., Director, Division of Educational Reference, Purdue University, LaFayette, Ind.

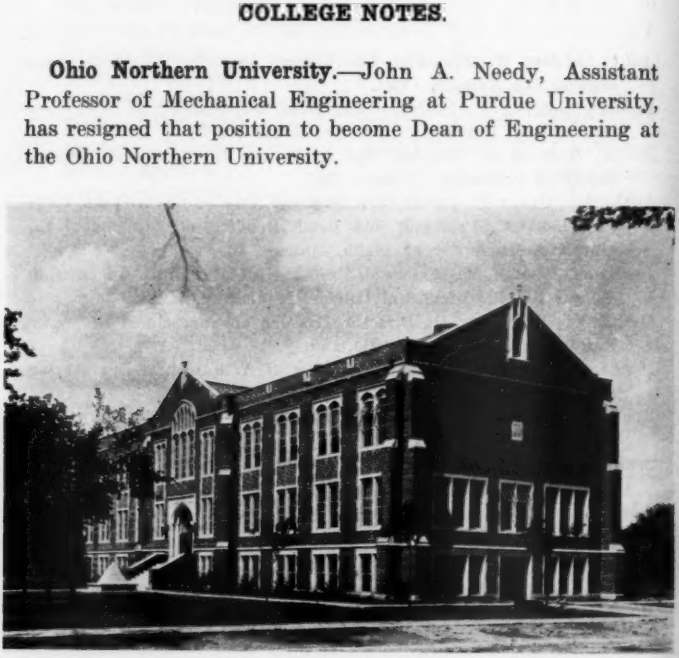
MORGAN, NEWLIN D., Assistant Professor of Architectural Engineering, University of Illinois, Urbana, Ill.

RUGG, W. S., Vice-President, Westinghouse E. & M. Company, East Pittsburgh, Pa.

SPENCER, WARREN R., Associate Professor of Civil Engineering, University of Arkansas, Fayetteville, Ark.

COLLEGE NOTES.

Ohio Northern University.—John A. Needy, Assistant Professor of Mechanical Engineering at Purdue University, has resigned that position to become Dean of Engineering at the Ohio Northern University.



ENGINEERING BUILDING, UNIVERSITY OF OKLAHOMA, NORMAN, OKLA.

Purdue University.—The enrollment at Purdue University at the end of the registration period was 3,316 and of these 2,071 are enrolled in engineering. Due to the fact that a considerable number of our graduate students and some of our upper classmen have not registered, I am of the opinion that the total enrolled in engineering during the present year will be at least 2,100. All of these students are enrolled either in civil, electrical, mechanical or chemical engineering.

Allen C. Staley, Associate Professor of Gas Engineering,

resigned to take a position as advisory engineer for a number of automobile concerns. Professor Staley is a graduate of Yale University and is an authority on automotive engineering. He has consented, however, to retain a connection with Purdue University as a Non-resident Professor of Automotive Engineering and will devote a certain number of days each semester in special lectures and conferences before the Purdue engineering students.

To fill the vacancy made by Professor Staley, Harry A. Huebotter, Research Associate of the Purdue Engineering Experiment Station, was appointed Associate Professor of Gas Engineering.

Harold Lee Maxwell was appointed Research Associate in the Engineering Experiment Station and Associate Professor of Chemical Engineering; William Alfred Bevan was appointed Research Assistant in the Engineering Experiment Station and Assistant Professor of Mechanical Engineering; George F. Buxton was appointed Professor of Industrial Training in the Engineering Extension Department; W. E. Howland was appointed Instructor in Civil Engineering; E. C. Brommer, Assistant Professor of Practical Mechanics, resigned. New appointments in the Department of Practical Mechanics Included: E. V. Farrar, Instructor; Walter G. Eichenberger, Instructor; O. H. Hamilton, Instructor.

Texas A. & M. College.—E. J. Fermier, Professor and Head of the Department of Mechanical Engineering, will represent the Society at the Semi-Centennial Anniversary of the founding of the Agricultural and Mechanical College of Texas, October 14 to 16, 1926.